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CHAPTER 18

Asian Ship-Building Traditions in the Indian Ocean at the Dawn of European Expansion*

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The Indian Ocean north of the Tropic of Capricorn is the only maritime expanse on earth that has been witness to the nautical ventures of most, if not all, major sea powers of world history. From East Africa to Southeast Asia and China, across some 3,500 nautical miles of water as the crow flies, the people living on its shores and on those of the South China Sea all sailed along its trading routes at one point or another during the last two millennia. Persians and Arabs plied most sea lanes, linking their shores to the rest of Asia and Africa. The people from most of the coastal regions of the centrally situated Indian subcontinent extended their trade networks on both sides of the Ocean. After occupying the island world of Southeast Asia in prehistoric times, the Austronesian-speaking people set sail in both eastern and western directions, for trade or migration, reaching places as far apart as Easter Island and Madagascar, in the process making the Indian Ocean very much a part of their *oikumene*. The Chinese only developed a high-seas merchant navy under the Song in the early second millennium CE, and were never a true Indian Ocean power. It is open to debate as to whether earlier references to ships said to be 'Chinese' or 'from China' in Arabic or pre-modern European texts ever referred to vessels built in China and sailed by the Chinese, or only to ships whose destination was China or which carried Chinese trade goods. After the Song launched their commercial expansion, and during the following Asian sea trade boom, some Chinese ships did sail to Indian and Middle-Eastern harbours, a commercial presence that culminated in the exceptional (but soon to be aborted) expeditions under Admiral Zheng He, who sent his large fleets all the way to the Red Sea and the East African coasts in the early fifteenth century.[1]

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Thus, when Vasco da Gama entered the scene through the back door at the end of the fifteenth century, he was but the representative of the last of the Old World powers to join the crowd: the nations of the Atlantic façade of Europe, spearheaded by the Portuguese, were now entering the Indian Ocean scene. In doing so, they heralded dramatic changes in world economy; but these would only mature and unfold in later centuries. What they found, as observed and described in the late fifteenth and early sixteenth centuries, was a multinational, complex maritime trade network in full swing, within which a wide variety of sophisticated techniques for building ships and sailing them were in use. In some 10 years, the time taken by the newcomers to reach the Eastern gates of the Indian Ocean, the Portuguese were to come across ships built and sailed by East Africans, Arabs, Gujaratis, Malabaris, Maldivians, people from Coromandel, Bengalis, Mons of Pegu, Malays, Javanese, people from Luzon, and Chinese, to speak only of the major trading powers that plied the Indian Ocean and the South China Sea waters in large sea-going vessels. Ashin Das Gupta, in a review article on Asian shipping, rightly called attention to the multinational, and therefore complex, nature of seafaring in the Indian Ocean of late medieval times.[2]

In order to try and understand this thriving maritime scene, there are many questions that should be posed by historians of Asia. General questions about who sailed and traded in the Ocean, about which products were exchanged, about commercial methods, etc., will not be dealt with in this chapter. Technical aspects of shipping, that is, the actual foundation of the maritime economy, should, I believe, be first—and best—studied *per se*. A study of nautical technology would in turn cover two quite different matters: how the ships were built, and how they were sailed and guided along sea lanes. The present chapter only attempts to address the ship-building subject, further limiting its scope to the study of the larger sea-going vessels that carried the long-distance trade. As F.C. Lane pointed out, 'the ships themselves pictured the trade'.[3] Only when this is achieved should the intimate ties and interaction between socio-economic history and the above concrete field of knowledge be explored, so as to try and master an integrated picture of maritime history.

It has become a platitude for maritime historians to lament on the scarcity of textual and iconographic evidence for the development of ancient ship-building techniques all over the world. In the area of our concern, very few new sources have been brought to light during the past years, except for data gathered by nautical archaeologists. Since the 1980s, radical developments in nautical archaeology have brought about tremendous progress in maritime history and given a new depth to the history of ships. Maritime archaeology departments have been set up in various countries. So far, unfortunately, no evidence has been gathered for pre-modern Indian or Middle-Eastern sea-going vessels in the Indian Ocean proper. The only recorded remains of an Arabo-Indian vessel were found in an archaeological context of a ninth-century shipwreck in the Java Sea. She carried a fascinating cargo, indicating that she had been trading in the South China Sea. Timbers were relatively well-preserved: the port side survived from the keel almost to the gunnel, and the full length of the keel survived along with thwart-beams, frames and keelson timbers. This is more than enough to confirm that it belonged to the Arabo-Indian tradition rather than to Southeast

Asian or Chinese traditions, as do all other pre-modern wrecks presently excavated in Southeast Asia.[4] A 1,000-year-old river or lagoon sailing barge was recently excavated inland in coastal Kerala: it is flat-bottomed, hard-chined, with little freeboard, and cannot therefore be considered a sea-going ship, but it does present technical features that are clearly not Arabo-Indian (and may in fact be related to Southeast Asian traditions).[5] To describe sea-going vessels of the Arabian Sea and the western and northern shores of the Bay of Bengal, we are thus left without hard archaeological evidence, and with the often quoted and repeated written or iconographic sources, complemented with ethnographic studies of fast disappearing craftsmen and their productions.

Crossing over to the eastern shores of the Indian Ocean into Southeast Asian waters, the scene undergoes quite a radical methodological change: historical research and ethnographic studies of still lively maritime trade networks have been dramatically enhanced, and at times amended, by the results of archaeological research carried out in the coastal and underwater sites of Thailand, Malaysia, Indonesia, Brunei, Philippines, Vietnam and Southern China. As will be seen further down, this has allowed for a thorough overhaul of our perception of the maritime world of Southeast Asia during most of the first and second millennia CE. Furthermore, pre-modern Southeast Asian maritime history is now studied within an overall reassessment of the nature of historical relations between the region and India. By now, interaction between the two cultures is known to have taken place across the Bay of Bengal in both directions (leaving behind such notions as Indian 'colonization' and a one-way imposition of Indian culture upon a passive and culturally backward Southeast Asia), and to have started centuries before the 'indianization' of parts of Southeast Asia took place after the third–fourth centuries CE.[6] The point of view of many an Indian historian, which to this day considers this a one-way traffic into a mythical 'Greater India', is clearly untenable: Southeast Asians, particularly the Austronesian-speaking people of the Malay World, did actively partake in this trade and shipping from the earliest times, as ship-builders, ship masters and traders. The reappraisal of Indian Ocean maritime history should also take into account these far from recent developments in our perception of the Southeast Asian past. In other words, one should not neglect looking at the Indian Ocean, particularly at the Bay of Bengal, from its Eastern shores.[7]

The decision to concentrate on late medieval times for this study is not an innocent one. The period was one of intense maritime exchanges, in which most powers of the Ocean took part in varying degrees, and were joined in their ventures by neighbours from the Mediterranean or the South China Sea. This in turn allows for a relative increase in written descriptions of the maritime scene after the thirteenth century, as witnessed by Arabic, Chinese or Western travellers, and culminating in the first Portuguese records, written at a time when Western influences could not as yet have been substantially felt in the ship-building field. This was still a time, to name only one structural detail, when all vessels of the Indian Ocean were built within a shell-first process, which, technically speaking, was a major difference between them and the European world of skeleton-first ship-building, pointing to a significant socio-economic divergence. This was also a time when Asian shipping networks were being profoundly transformed by economic forces that would build up the world trade boom of the 'long sixteenth century'.

SHIP-BUILDING IN THE ARABIAN SEA

Asian and Western travellers from the thirteenth to the early sixteenth century left us a fair amount of more or less technical descriptions of the craft they most often came across, and later had to compete with in trade or war. Unfortunately, with a few exceptions, their precise origin, that is, the place of their building or the ethnic group to which the shipwrights belonged, is not mentioned. Expressions such as 'ships of India' are more often than not encountered; 'ships from Calicut' may seem more informative, but this is misleading: it may as well, depending on the context, refer to vessels proceeding from Calicut but built elsewhere, or to others that belonged to a merchant community based in that city but of a culturally different origin. Only when dealing with Gujarati ships do the observers seem to be describing a special, regional type of vessel, as will be seen later in this chapter.

The Arabo-Indian Ship-building Tradition

Due to the absence of any precise indication of origin, the general impression gathered from a comparison of Portuguese descriptions at the turn of the sixteenth century with earlier Asian and Western ones, as well as from an extrapolation from observations of the nineteenth and twentieth-century scene, is that of a broad class of vessels akin to the present-day Arabo-Indian *dhows*.[8]

Such vessels would have been in general use from the East African coast to the Western coast of India and, to a lesser extent, in the Bay of Bengal: their builders and sailors would have been Arabs and Persians, other Islamic communities established outside the Arabo-Persian world, and possibly also non-Muslims. As in modern times, the external aspect of various types of vessels forming this class would have varied widely. Few coeval descriptions are precise enough, though, to allow us to get into this kind of detail. However, they obviously shared essential structural characteristics, which led foreign witnesses to perceive them as one broad class of vessels.

The most widely acknowledged feature of the ships built in the Arabian Sea, ever since the early first-millennium *Periplus of the Erythrean Sea* was written, was the sewing of their various components: the sewn-plank technique, by then long forgotten in Europe or China, was obviously considered very exotic and always noted down, usually with some sort of derogatory remark on its apparent fragility.

Gaspar Correa, always a careful observer of nautical techniques, left us the longest and most detailed description of ships observed in Angediva and Cannanore at the turn of the sixteenth century. He states that their strakes were stitched together with *cairo*, a term of Dravidian origin widely used for the twine made of the fibre of the coconut tree (*Cocos nucifera*).[9] Correa is the only contemporary witness who bothers mentioning the frames of these craft: he writes that there were only a few of them, and that they were likewise sewn to the planks.[10] He concludes that these ships were thus 'made as strong as if they had been nailed' (proving himself a far shrewder observer in those matters than most of his contemporaries). I thus cannot agree with Moreland when he writes that the absence of frames was an essential feature of Arabian Sea craft about 1500 CE.[11]

Another way of making the hull of a vessel structurally stronger is to insert wooden dowels into the seams of the planks, so as to help in keeping them from riding apart under stress. The complete text of Marco Polo clearly refers to dowels used in ships from Hormuz:

> [Their ships] are not nailed with iron pins like ours (...) but the planks are bored with iron drills as carefully as they can at the ends, and then are fixed with little treenails [that is, dowels]; afterwards they bind them or they are sewn with coarse thread which is made of the husks of the trees of nuts of India (...).[12]

The chronicler Damião de Gois clearly referred to dowelling of an East African vessel and Maldivian craft certainly had treenails (although the latter case might have been a direct Southeast Asian input, as discussed below). Later observers such as Gemelli Carreri (1695) or modern use would also tend to prove that dowels were in use in earlier times: indeed, this is not a technique that would have been imported by Europeans, who no longer used it. It had been in use in Southeast Asia, however, for many centuries, as evidenced by their appearance in early first millennium CE ship remains.[13]

Patronizing Western travellers of the thirteenth to the early sixteenth century, with no historical hindsight to temper their statements, were, when describing Asian vessels, almost unanimous in contrasting the 'weak, uncouth' sewn-planked ships of the Indian Ocean with their neighbours further East, particularly the sturdy, iron-fastened sea-going Chinese junks. There obviously were inherent weaknesses in sewn-plank techniques, most of which would probably have been taken care of during regular overhauls of the stitching and the planking. The flexibility inherent to their design, however, is now considered a quality. After all, 50-year-old *odam*s of the Laccadives, built without one single iron nail, have been reported in recent times.[14] Moreover, the mere fact that they were then ubiquitous within Indian Ocean trade networks and remained so well into the twentieth century does overwhelmingly prove that they served their purpose as sea-going trading ships. A successful re-enactment by Tim Severin and his crew of a mediaeval trip from Oman to Canton on a 25 m long Arabian sewn-plank vessel built following early techniques (with dowels) no doubt reinforces this point of view.[15]

In the whole of the Indian Ocean (as well as further East), water tightness of the hull was generally achieved by inserting some kind of resin and eventually vegetal fibre between the edges of the planks to make them leak-proof (only master craftsmen, in Europe as well as in Asia, would have been skilled enough to achieve a perfectly fitting surface between two planks, and would thus not have needed to use some additional techniques). On these grounds, Jan Qaisar contrasted Western and Asian ship-building techniques and argued, on the basis of seventeenth-century English sources describing Gujarati vessels, that Asians did not caulk their ships, deriving from this point arguments about the superiority of Indian techniques and their lower cost. However, one must understand that seventeenth-century Western sources do have to be considered from the point of view of those who wrote them. Western craftsmen, for as long as they could remember, had been building their ships 'skeleton first'—meaning that the frame structure was built and the hull planks (the shell) was only then assembled by nailing it to the frames. Thus there was no fastening of the planks together, and the solidity and water tightness had to be achieved by caulking (that is, by forcibly driving strands of fibre from the outside into a somewhat gaping seam and covering it with pitch to prevent rot; this operation could only be done after the hull was assembled). In contrast, the 'shell first' assembling tradition of medieval Asia and the usual sewing or lashing of the strakes implied that water tightness had to be achieved before the strakes were fastened together. There is thus no point in opposing two different techniques that served the same purpose. Rather than the term 'caulking', one should use 'luting' for the Asian process (that is, in this case, laying a soft stopping in a joint before assembly).[16] In the Indian Ocean, as often described by Chinese or early Western sources, luting was done by applying a mixture of oil and *damar* on the seams of the planks ready to be fastened (*damar* was a widespread word of Malay origin used for resinous exudations of a wide variety of tropical trees). Other Portuguese authors call this 'wild incense'.[17] Correa says they used *kil*, a word found in Dravidian languages as well as in Arabic and Persian for pitch or bitumen, which served the same function as resins.[18]

Additional protection was provided to the hull by smearing the inside of it, particularly the coir stitching, with fish oil. The submerged parts of the vessel were finally kept teredo-free by plastering the outer side of the hull with a mixture of fish-oil, burnt lime and pounded vegetal fibre. This thick white mortar was impenetrable to water and acted as an anti-fouling coating. The term used to refer to it was *galagala* (or cognate forms): it appears in early Western sources as well as in many Southeast Asian and Indian languages.[19]

Hulls of pre-Portuguese times would still have been double-ended, coming to at both stem and stern. The transom stern of later dhows, with their galleon-like aft-castle, are obviously Western-influenced innovations (the Persian Gulf term for it is *kashtil*, an obvious borrowing from Portuguese).[20] It seems that many of these craft had a hull with a V-shaped section and a keel, as clearly stated by Correa. One possible common feature, judging from the often published thirteenth-century ship pictured in al-Hariri's manuscript, from the sixteenth-century Tirupputaimarutur fresco, from the ships depicted on the Indian Ocean sheet of the 1519 Lopo Homem/Reineis atlas, as well as from modern dhows, is a very characteristic, long projecting stem.[21]

Except possibly for some sort of raised poop-deck, under which cabins may have been found in larger craft, it seems that most Arabian Sea vessels would have had an open main hold, with no deck: no classical Arabic text mentions the latter, and most other descriptions of the thirteenth to the sixteenth centuries agree on their absence. On large cargo ships observed in Cannanore around 1500, according to Correa,

> in lieu of decks, the hold was built up with huts and compartments for merchandise, covered with plaited palm-leaf thatch, acting as a roof; the water would flow down to their sides, then along the hull and gather at the bottom of the hold where it could be bailed out, thus not wetting the merchandise which was kept well packed into these compartments. On top of these thatched roofs, they would dispose strong cane lattice-work, on which one could walk without damaging the huts below. (...) People have their lodgings on top, for nobody stays below, where the merchandise is found.

This is probably the kind of cover referred to in an obscure passage by Ibn Majid.[22] Along the whole length of the ship, a weather-screen made of coarse cloth dipped into bitumen, reinforced by solid, water-proof matting, was set up for further protection above the gunwale. Both Marco Polo and Wang Dayuan (in his *Daoyi zhilue* of 1350) describe the way in which ships exporting horses from the Persian Gulf were loaded: bulk cargo, such as frankincense, was stacked at the bottom of the hold and was then covered with hides, on top of which stood the horses. On a smaller scale, this is probably the type of horse-carrying vessel depicted in the sixteenth-century Tirupputaimarutur fresco.[23] Hornell describes the Konkan and Malabar pattamars he came across in India in the mid-twentieth century in terms very similar to those used by Correa:

> when laden, a weather screen of matting and bamboos is set up, further protection for cargo and crew been provided by a rude pent-house structure thatched with coconut leaves, erected between the masts. Forward and aft there is a short length of the hull roughly planked over, with the waist covered by a lattice-work of split bamboos, sufficiently strong to support a man's weight.[24]

Figures on tonnage are not often quoted in sources in direct relation to this particular class of Arabo-Indian vessels. Barbosa observed 'very small' ones on the East African coast, and he says those of Calicut would run to 1,000–1,200 *bahar* (that is, 180–200 tons). The anonymous narrator of Pedro Alvares Cabral's voyage writes of vessels of 200 *botte* (=100 tons), seen at Melinde.[25] Some were probably larger, but the general impression remains that of smallish vessels, particularly when compared, in the same sources, with the imposing 'naos' of Gujaratis or with the average Southeast Asian or Chinese trading craft of the period.

Another common feature of the Arabian Sea vessels was the steering gear. The double quarter-rudders had recently been abandoned, both in the Mediterranean and in this part of the Indian Ocean, in favour of the single stern-post rudder. One of the hero-stones with boat depictions at the Old Goa Museum has a small-oared vessel with a clearly central rudder: the stone is said to be of the twelfth century; if this date can be trusted, then we have the earliest reference to such a steering gear in the Indian Ocean.[26] The first textual references to this central rudder are found in Marco Polo's chapter on Hormuz, and in the often reproduced 1237 CE al-Hariri manuscript.[27] In 1290, John de Monte Corvino described it as 'a frail and flimsy rudder like the top of a table, of a cubit in width, in the middle of the stern'.[28] A letter written from Lisbon in 1503 by the Florentine merchant Girolamo Sernigi, after information gathered when Vasco da Gama's fleet returned to the Portuguese capital, states that the ships of Calicut 'have their rudder fastened with ropes, and it is longer than the stern-post of the ship (...)'.[29] Rudders fastened to the stern-post by way of pintles and gudgeons were a later Western import into the area: Sernigi's description could thus be interpreted as meaning that they were attached to the post with ropes. Correa has another rather ambiguous passage on the matter: 'They have their rudders attached to the vessels with ropes on the outer side'. This may also be understood as referring to the lines attached to each side of the rudder, which were held by the helmsman to steer the vessel. In fact, the same author again, in an earlier passage, writes that 'they have a very broad rudder made of thin planks, and from the outside of the hull, on each side, they have ropes with which they pull on the rudder to steer the ship'.[30] Such tiller-less steering gears are well depicted in the al-Hariri manuscript and in the sixteenth-century Tirupputaimarutur fresco, and could still be observed in modern craft a few years ago. That there was no tiller in the European fashion is further confirmed by the fact that the modern word for tiller in Arabic as well as in Dravidian languages is *kana*, from the Portuguese *cana (do leme)*.[31]

First-millennium CE ships depicted in Indian frescoes, bas-reliefs or coins often carried more than one mast, a fact confirmed by contemporary textual sources.[32] However, with the exception of a few ambiguous references to more than one sail (not necessarily masts) in later Arabic texts and in some of the ships depicted with a mizzen-mast in the Lopo Homem/Reineis map, late mediaeval sources are unanimous in referring to single-masted ships. No mizzen-mast or sail are mentioned, and jibs are known to be a recent innovation.[33] It is impossible at this stage to do better than hypothesize the adoption during the second millennium CE of a new rigging tradition, which would have followed, with considerable delay, the spread of the dhow-like class of Arabo-Indian vessels we have been describing (modern dhows of some size would usually sport two masts and sails, but that could well be a recent innovation).

The material with which the sails were made in Malabar, according to John de Monte Corvino, was 'either of matting or some miserable cloth'. Two centuries or so later, Barbosa still found sails made of mats in East Africa and the Maldives, and so did the anonymous chronicler of Vasco da Gama's voyage. The transition from matting to cotton sails was thus not complete in mediaeval times, as indeed it was not in the early part of the twentieth century.[34]

Arabs, in the Mediterranean as well as in the Indian Ocean, have always been associated with the modern lateen: a tall, triangular, high-peaked sail lashed to a long fore-and-aft yard hanging from a forward-raking mast. This is no doubt true of all Arabo-Indian craft nowadays. Modern lateens of the Indian Ocean differ from those of the Mediterranean only in that they have a short luff edge, and thus are very much like the pure triangular lateens. Hourani, amongst others, has no doubts that 'the typical sail of the Arabs is the lateen, in fact it is the only sail used by them, now or at any recorded time in the past, from Morocco to India, the Persian Gulf to Mozambique'. The famous 1237 al-Hariri ship, however—as published by Hourani himself—has a set of odd sails that, however awkwardly drawn, cannot be mistaken for lateens. The sixteenth-century Tirupputaimarutur ship, although again quite awkward, represents a clearly rectangular sail. At this stage, we are reminded both of the modern square lug-sail of the East African *mtepe* or of the Minicoy fishing boat, and of the square sails of the ancient Indian ships (as depicted, for instance, on the Ajanta frescoes).[35]

Correa, once again, in the descriptions he gathered from ca. 1500 witnesses at Cannanore, provides us with a precise clue as to the exact shape of the sails and the rigging, both standing and running, of the Arabian Sea vessels: the yard had one-third of its length fore and two-thirds aft of the mast; the leach (that is, the aft vertical side of the sail) was only one-third longer than the luff (the fore vertical side); they had no top-sails, only one main sail. The sail thus described is almost square: this in turn exactly confirms the 3:4 relationship between the luff and the leach, as mentioned in the fifteenth century by Ibn Majid. The dhow-like ships depicted on the Lopo Homem/ Reineis atlas similarly sport squarish sails.[36]

Contemporary observers thus appear to all agree on the fact that the late medieval Arabo-Indian vessels do not sport a lateen. What they have is a boom-less ‘canted square-sail’ (actually a rectangular sail) or, in other words, a ‘dipping lug-sail’. This type of sail is comparable to those sails rigged on modern craft built east of Cape Comorin. One should moreover note that some of the Arabian Sea craft measured and published by Admiral Pâris in the early nineteenth century still have canted sails with an approximately 1:3 relationship between luff and leach, which puts them somewhere in between those of the fifteenth century described above and the lateen with a very short luff of the modern Arabo-Indian dhows. The latter therefore appears to be a relatively recent innovation.

This is no place to start anew a theoretical analysis of the much-discussed origins of the lateen sail: it should nevertheless be noted here that the seemingly general use of a canted square-sail in the Arabian Sea at such a late period casts serious doubt on the theories of a Far-Eastern origin of the lateen: if such was the case, one would not find true lateens in the Mediterranean before late mediaeval times (whereas it is attested there as early as the ninth century CE).[37]

The Gujarati Ships

Only one class of Western Indian Ocean vessel stands out in Portuguese descriptions of the late fifteenth and early sixteenth century, namely that used by the ubiquitous Gujarati merchants: not only are these craft usually ascribed a precise origin—Cambay—but they are also normally called *naos* in these sources, a term of Latin origin usually meant for the large round-bottom trading vessels of the Portuguese. From the Red Sea to Melaka, these Gujarati vessels, often larger than their own *naos*, were a constant reminder to the Portuguese of their weaknesses at sea. Tomé Pires states that the ‘Gujaratis were better seamen and did more navigating than the other people of these parts, and so they have larger ships’. Some of these, such as the Meri, a ship belonging to the Sultan of Gujarat taken in Hormuz in 1510, could run to as much as 800 tons and carry 1,000 men. The average trading Gujarati vessel would have been somewhere around 300–600 tons, such as the one sunk in 1510 near Melaka, which was 540 tons and carried 250 people aboard.[38]

Historians of Gujarat are now well aware of the essential role played by these huge vessels in fifteenth and sixteenth-century trade networks. Surprisingly enough, though, little is said of their build apart from the fact that they were larger than average. We know from the anonymous narrative of Cabral's voyage that in 1500, they were 'very well built, with excellent timber, and nicely sewn with ropes, as they do not have iron nails; they are caulked [that is, luted] with a mixture in which there is much incense; they only have an aft-castle'. One is also told elsewhere that they have no keel (meaning a rounded hull, as opposed to a V-shaped one?), that 'they are sewn with coir like those of Malabar and that they can load a lot, as they have no deck'.[39]

The latter are familiar features by now: only their larger size and their round-bottom hull would appear to differentiate in coeval sources the Gujarati *naos* from the previously described vessels of the Arabian Sea. However, seventeenth century and later sources describing ship-building in the area ranging from the coast of Konkan to that of Sindh do describe a unique technique for assembling the planks, the only one known to local shipwrights. Instead of bringing together at the seams two flush surfaces, as in the regular Arabian Sea way, Z-shaped grooves were carved into the facing sides of the planks in such a way that they closely fitted into each other; strands of fibre and the usual putty made of a mixture of fish oil and resin were inserted into the grooves before the strakes were fastened.[40]

This rabbetting technique (inadequately called 'tongue-and-groove' by Hornell) is known in Gujarati as *vadhera*. It has always been linked by those who described it in the seventeenth century and later to the fastening of the planks by long, curved iron nails. However, there is no reason to believe that the rabbetting of the planks would have suddenly appeared in the seventeenth century when it was first documented (iron nails had by then become a common occurrence). Actually, the fact that stitching was still in use in the nineteenth-century *vadhera* assembling process, to bring the planks close together before nails were driven in, does suggest a survival from a former sewn-plank technique (these stitches were disposed of after nailing, and the holes plugged). Thus, the sewn-plank Gujarati ships of the late fifteenth and early sixteenth-century Portuguese sources would most probably have had rabbetted planks sewn together in a nail-less *vadhera*-like procedure.

Nailed Ships in the Fifteenth Century?

One major problem remains: when were iron nails first used in the western half of the Indian Ocean to fasten planks together? Sewn-plank techniques were clearly the commonest at the turn of the sixteenth century (although, again, their exoticism may have made them more conspicuous to foreign observers, thus rendering them more visible in surviving sources). Prolonged European influence no doubt brought iron nails into common use, as is already made clear by seventeenth-century sources.[41] Three references to their use at the turn of the sixteenth century were dismissed by Moreland, who argued that these could have been quick imitations of the Portuguese or interpolations by authors writing later into the century, after a longer exposure to Western influence had taken place. I believe there is little at hand to warrant such restrictive interpretations of the three passages.[42]

Ludovico de Varthema left India as early as 1507; on technical grounds, his descriptions of ships seen at Calicut are particularly accurate in every other respect, and I see no intrinsic reason to reject his remark that 'they have a large quantity of iron nails' (the only restrictive comment would be that his text is ambiguous enough to be interpreted as applying to all ships). Castanheda confirms this assertion when he writes that many nails were stored in the shipyards of Goa in 1509, when a fleet was being built there to resist Portuguese attacks; he refers to a precisely dated event and the fact that he writes some decades later is irrelevant. Finally we have Correa's account, again written later in the century; but he clearly states in the relevant passage that 'all that he describes was witnessed by our people in the harbour of Cannanore (...) as ordered by the Captains [of Vasco da Gama's 1498 fleet], so that they could give an account of it when they returned to Portugal'. As usual, Correa's is the most striking piece of evidence. The Portuguese observed two types of ships: the usual sewn-plank type and another one with broader bottoms and no keel, 'the strakes of which were nailed together with thin nails with broad heads, riveted on the inside with false heads of the same size'. 'What is called rivetting worke', concluded a seventeenth-century English source after describing a similar process in the Bombay area. The striking convergence of the latter two quotations brings further credibility to the Portuguese accounts. The Nestorian priest known as Padre José, a fourth witness not quoted by Moreland, also stated that in the early years of the sixteenth century, ships built at Cranganor were assembled with nails.[43]

Correa's quotation, however, raises a slight problem of interpretation: he specifies that planks were held together by nails and the latter were riveted. This sounds like an impossibility: nails used to fasten planks together could only have been driven obliquely and their points sunk into the timber (excluding any 'rivetting worke'); riveting could only have been meant for nails driven into the planks from outside and across the frames, so as to secure the shell to the ribs; the protruding points of these nails would then be clenched over rovers or washers, thus obtaining a riveting effect. Both procedures—fastening of the planks together and fastening of the latter to the frames—are complementary. In fact, *vadhera*-type rabbetted strakes were also nailed or riveted to the frames (in modern times, riveting seems not to be found in Gujarat: the inner ends of the long nails driven through planks and frames are beaten down to act as clamps).[44] We will see further down that plank-fastening traditions in the Maldives also went from stitching to riveting, thus confirming that this was a regular evolutionary process.

These remarks raise yet another question. Were the fifteenth and sixteenth-century nailed ships observed by our four different witnesses from Gujarat, or did they use techniques developed in Gujarat? The similarities between the modern Gujarati *vadhera* technique and that described by Correa, the fact that both nailed ships and Gujarati ships were said to be round-bottomed and to have no keel, the fact also that seventeenth-century sources ascribe the general use of iron nails to ships built in the Gujarat area, do all point to such a conclusion. However, sources from the turn of the sixteenth century never say so explicitly: on the contrary, we have seen that Gujarati ships were said to be sewn 'like those of Malabar'. At this stage, it is preferable to leave the question open, until further information is brought forth in new archival sources or after nautical archaeology provides us with solid data.

Whether the use of nails was developed locally, in an autonomous way—if there ever was such a way in a maritime trade network environment—or adapted from foreign techniques, it certainly could not have been developed during the first few years of Portuguese presence (and far less, of course, under direct Portuguese influence). No doubt local shipwrights were quick to adopt European techniques; however, such adaptations could not possibly have taken place in such a short time had earlier developments not prepared the ground for new improvements. If one wishes to explain the use of nails on the western coast of India by arguing an imitation of foreign models, it seems much more reasonable to attribute this to Chinese or possibly South China Sea influences: large trading vessels from both areas were often seen in the Indian Ocean harbours until the fifteenth century, and both used nails.

SHIPBUILDING IN SRI LANKA AND THE EAST COAST OF INDIA

As we reach the eastern half of the Indian Ocean, the overall picture we may draw of the ship-building scene undergoes radical changes, and we sail into a *mare incognitum.* The main reason for this is the nature of the available evidence: it is almost totally lacking for the period considered here, be it textual, iconographic or archaeological.[45] Considering this problem of sources, it is no surprise that the picture is particularly blurred for the Bay of Bengal. There is little doubt that Sri Lankans, Tamils, and their neighbours further north did sail and trade at various historical times in their own craft across the Bay of Bengal towards the shores of Southeast Asia, and no doubt they did so all the way to the South China Sea and the southern Chinese harbours. What is still lacking is evidence on the structures of their sea-going ships.

Sri Lanka and the Coromandel Coast

The first hypothesis to come to mind when one considers the striking lack of textual evidence on sea-going ships built on the western shores of the Bay of Bengal between the thirteenth and the early sixteenth centuries is that large locally-built vessels would no longer have been used by Sri Lankan and Tamil merchants in their trading ventures when such descriptions were being recorded. This is a very radical step to take; considering the survival into modern times of a clearly local tradition of ship-building, and the isolated evidence of the sixteenth-century Tirupputaimarutur fresco (depicting a small to medium-sized horse-carrying vessel of the Arabo-Indian tradition), one may limit the bearing of this hypothesis to the larger ships used in international, long-distance trade, allowing for the survival of smaller coasters serving only inter-regional trade (and to which foreign travellers would have paid less attention). This would best fit the picture that may be drawn from historical studies on the area: by the early fifteenth century, the ports of the western coast of India and those of Pegu and the Straits of Melaka had become the focus of international trade networks, largely leaving other regions in a position of secondary suppliers. On the Coromandel coast, only Pulicat would have maintained regular trans-oceanic connections with Southeast Asia. However, out of the half-dozen large ships plying annually on the route to Melaka, a large proportion does seem to have been of Southeast Asian build and owned by the Tamil community established in the Malay city-state.[46]

In Sri Lanka, the tradition of building large trading vessels appears to have been alive until the twelfth and thirteenth centuries. However, quoting Gunawardana, 'Though the technology of nautical construction was available, avenues in which it could be profitably utilized were becoming increasingly hard to find. In a context of diminishing opportunities for commerce, the technology itself was bound to decline.' Tomé Pires only writes, with no further details, that the land of Ceylon 'has a few ships of its own', which traded from Bengal to Cambay.[47]

The larger outrigger-less coasters of the early twentieth century observed by Hornell and others in Sri Lanka and southern India stand a good chance of being the descendants of earlier vessels. They could still run to 300 tons burden, which makes them fairly large craft. Their planks were sewn together with coir, in a fashion comparable to that used in the Western Indian Ocean. However, both the overall shape of their hull, of the penthouse roofing of palm leaves and of the rig (multiple masts with square sails and foresails) appear to indicate that their ship-building tradition was distinct from that of their better-known Arabo-Indian neighbours. Then again, some of these characteristics are reminiscent of traditions common further East across the Bay of Bengal, or possibly also of features of ships depicted in ancient Indian iconography and texts.[48] Having been unable to rely on either late medieval or modern descriptions of these vessels precise enough to provide structural details that would allow for a reliable comparison with ancient and modern traditions of western India and Southeast Asia, there is little more that can be said on technical grounds alone.[49]

On linguistic grounds, though, there are elements which tend to further indicate that Southeast Asian and Bay of Bengal traditions (and possibly those of the west coast of India, which were superseded by the development of the Arabo-Indian techniques) did share a so far undetermined range of common characteristics. Various terms used to designate different types of vessels are common to languages of both sides of the Bay of Bengal (and at times further East or West). The term *wangkang* and cognate forms are found in Old Mon inscriptions as well as in most Austronesian languages, including those spoken in the Pacific. It has been reconstructed into the Proto-Malayo-Polynesian stock, which establishes its Southeast Asian origin. It is, however, attested under the form *vangkam* in a Tamil nautical treatise of the sixteenth century, and in a variety of Tamil texts of various periods, where it designates a large plank-built vessel; its earlier attestations appear to be in the early first-millennium CE Sangam texts such as the *Maduraikkañci*, where it is the most common term for a ship. The term must therefore have been adopted into Dravidian languages at the beginning of the first millennium CE at the latest, proving that exchange of vocabulary and probably technological transfers were then already underway. The well-known Malay and Javanese term *perahu* / *parawu* for ship is no doubt cognate to the Dravidian *pataku* / *patavu* / *padahu*, with the same meaning. This has long been said to be a word of Dravidian origin, as it appeared not to be attested in Austronesian languages earlier than in ninth-century inscriptions. Linguists, however, now appear to have reconstructed the term into proto-Oceanic, which would also make it another word of Austronesian origin. Another well-known word of possible Austronesian origin is *sampan*, attested in a 684 CE old Malay inscription, which also appears in Tamil and Sri Lankan (as it does in Khmer, Thai, Burmese, Mon and Chinese). The Malay term *kapal* has also for long been said to belong to the Dravidian stock (*kappal*); it does not appear in Tamil literature before the seventeenth century, though, and its Indian origin may be open to doubt. It is also not, however, attested in Austronesian languages earlier than in sixteenth–seventeenth century classical Malay texts, in which it is always used for foreign vessels. Its case must for the moment remain unresolved.[50] The fact that such common words do seem to have travelled across the Bay of Bengal is a clear indicator of an ancient community of nautical traditions. Sunil Gupta, on different grounds and for an earlier period, has also hypothesized the existence of what he terms a 'Bay of Bengal interaction sphere'.[51]

Bengal

Further north, Bengal raises slightly different problems. Although unfortunately not describing the vessels themselves, early sixteenth-century Portuguese sources are very clear about one fact: Bengalis used two classes of ships, namely the *juncos* (this is the most Western occurrence of their use), and the *naos*, sometimes classified as 'mauriscas', that is, of the Moors, which probably indicates that they belong to the Arabo-Indian tradition. For Tomé Pires, 'Bengali merchants sailed in *juncos*'. Barbosa, though, writes of the two classes: they have 'great *naos* after the fashion of Mecca; others are from China, which they call *juncos* which are of great size and carry great cargos'. Other Portuguese documents such as a 1527 letter to the King write about '*naos* of Bengal'.[52]

With these ships the Bengali merchants are said to have sailed as far as Cambay and Melaka. Are we to understand from these statements that Bengalis did not build their own merchant vessels, but purchased them elsewhere: the *naos* (*mauriscas*) in the western part of the Indian Ocean, from fellow Muslim merchant communities, and the *juncos* somewhere in Southeast Asia (rather than China, as stated by Barbosa; as will be seen below, the *juncos* were a typical Mon or Malay World product)? Ship-building traditions of the Ganges Delta, as observed in post-eighteenth century sources, were exceedingly well-developed and offer some original features such as clinker-built boats or rabbetting of the planks (as in Gujarat: would the above-mentioned *naos* have been from Cambay?). None of these modern craft, though, appear to have been large sea-going vessels.[53]

Only the large sea-going, plank-extended dug-outs of Chittagong, in the southeast of Bangladesh, remind us of Southeast Asian craft: but we are by now entering Southeast

Asian waters, in a region that has undergone prolonged Mon influence. This closeness to the Mon area, known for its building of large trading *juncos* in the fifteenth and sixteenth century, may account for the fact that these were then in common use in Bengal.

THE SOUTHEAST ASIAN AND SOUTH CHINA SEA TRADITIONS

As we reach the Eastern shores of the Bay of Bengal and sail into the seas of Southeast Asia, we come across studies on seafaring and ship-building that have a long tradition, with multiple approaches, based on linguistic, ethnographical, textual and iconographic data (particularly when describing its Polynesian and Indian Ocean extensions, as in works on the diffusion of outrigger technology). Taken together, these allowed scholars to progressively acquire a meaningful knowledge of a long-established seafaring civilization, principally among the Austronesian-speaking peoples of Insular Southeast Asia, who are known to have been among the early Asian developers of sophisticated nautical techniques (amongst which was high-seas navigation).[54] In strong contrast to the regions we have just surveyed, moreover, nautical archaeology has thoroughly enhanced our knowledge of ancient local ship-building traditions (not to speak of the foreign ships excavated in Southeast Asian waters).

The Southeast Asian Tradition

The survival into modern times of vigorous fishing and regional trading activities turned the Southeast Asian seas into a repository of maritime technologies that were often forgotten elsewhere in the world (including, until the late 1970s, large traders). As in the earlier part of this chapter, we will, however, limit ourselves to the study of the larger high-seas trading vessels.

The large mid-first millennium CE stitched-plank ships of Southeast Asia were first identified from contemporary written Chinese records, which described vessels up to 50 m in length, carrying some 300 tons of goods and passengers in the hundreds, sporting multiple masts and sails, and with hull planks fastened with vegetal fibres. Their existence has now been abundantly confirmed by the archaeological records. They belonged to a clearly identifiable local tradition, different from that of the sewn-plank ships indigenous to the western parts of the Indian Ocean: fastening of their planks was done with vegetal fibres taken from the sugar palm tree, using separate stitches, and with frames lashed to lugs carved out of the interior side of the planks (hence the 'stitched-plank and lashed-lug' category devised for these vessels, to differentiate them from Arabo-Indian vessels of the 'sewn-plank' tradition, with a long strand of coir driven from hole to hole all along the seams).[55]

Chinese sources refer to such Southeast Asian ships plying China Sea and Indian Ocean lanes as early as the third century CE, and we know from the same set of sources that the Buddhist monks who sailed on them in the seventh century CE towards the Srivijaya harbours of Sumatra and the Malay Peninsula boarded the same vessels on their way to and from harbours in the Bay of Bengal. After the twelfth–thirteenth century, the stitched-plank and lashed-lug tradition evolved, in large sea-going vessels, into a more rigid type of fastening: wooden dowels progressively replaced all fastenings of hull elements with vegetal fibres (a tradition that survives to this day only in the smaller fishing craft of Taiwan and Eastern Indonesia).

The first clear accounts of early modern ships built on Southeast Asian shores for locally established merchant communities are to be found in early sixteenth-century Portuguese records: the first *juncos* (as the Portuguese systematically referred to them) encountered in the Straits of Melaka were impressive vessels in all respects. The Portuguese word *junco* is a regular transcription of the Malay and Javanese *jong*, commonly used in the sixteenth-century classical Malay texts for large trading ships. The earliest occurrence of the word is found in a ninth-century Old-Javanese inscription.[56]

Their tonnage was considerable: these *jong*s could run to an average 400–500 tons; an exceptionally big one, built in Java in 1513, reached 1,000 tons and could carry 1,000 people aboard. Second, the *jong*s were built without a single piece of iron. The planks of the V-shaped, double-ended hull were edge-fastened by using wooden dowels inserted into their seams, and the shell was in turn dowelled to the frame (with the usual shell-first procedure). The earlier stitching and lashing of planks and frames had thus been abandoned for some time. Another characteristic feature was the multiple sheathing of the hull: as one layer of planking became old, additional plank layers were superimposed on the first. Ships were known to have up to three such layers, which allowed them to resist Portuguese cannon shot with no damage. Holds were separated into compartments which were in turn separated by walls of bamboo matting. A penthouse roof made of matting covered the undecked hold (except possibly for the aft- and fore-most parts).

A very important feature was the steering gear: contrary to the western half of the Indian Ocean or to China, Southeast Asians remained faithful to the double quarter-rudders (as they indeed have until the present time in Indonesian waters).[57] The *jong*s had multiple masts and sails, usually from two to four, plus a bow-sprit on which a foresail was rigged (similar bow-sprit sails appear on vessels depicted on eighth-century Borobudur reliefs, and on the sixth-century Ajanta frescoes). Sails seem to have always been of vegetal matting. The canted square sail seems to have been most commonly used, as it was recently on many boats in Indonesian waters. In the early sixteenth century, these ships were principally built near the main Southeast Asian sources of timber, that is, the northern Javanese coast, the southern coast of Borneo (both in the Austronesian-speaking area) and, prominently, in Pegu (in the Mon area), where they were built for the merchants of Melaka.

To the best of my knowledge, all sixteenth-century textual sources, both printed and manuscript, clearly refer to the Southeast Asian *jong* as a vessel built entirely of wood; not a single nail was used to fasten her components together, only wooden dowels. Such a ship-building tradition was by then no doubt very common in the whole area, as it had remained until very recently for the larger traders of Indonesia (particularly in the Bugis and Makassar ships from Sulawesi).[58] These ships, during the fifteenth and until the second part of the sixteenth century, appear to have been the main carriers of the Southeast Asian traders based in Melaka, Java and the Philippines.

Portuguese sources of the sixteenth century allow us to partially reconstruct some of the earlier trade routes on which the Malays and Javanese operated during the worldwide economic boom of the fifteenth and the sixteenth centuries, carrying cargoes that belonged to rulers and merchants based in Melaka, and in various harbour-cities of the Straits area and the Java Sea. By then, only a few decades before the Southeast Asians' withdrawal from high-seas shipping in the second half of the sixteenth century, they chiefly sailed to Southern China, the Moluccas and Coromandel. However, these sources carry clear indications of late fifteenth or early sixteenth-century Indian Ocean trips, leading them as far west as the Maldives, Calicut, Oman, Aden and the Red Sea.[59]

It appears that *jong* trading, at the time the Portuguese came into the scene, was no longer what it had been some decades earlier: local vessels were still very large, but the remotest destinations had been abandoned, leaving only southern India and China open to their enterprise outside of Southeast Asia. A sizable proportion of Melaka-based merchants sailing these large *jong* in the 1510s belonged to non-indigenous Southeast Asian communities. Prominent among them were the Tamils involved in the Moluccan spice trade, where they competed head on with Javanese merchants and appear to have taken the lead. The Gujarati merchants and their *naos* had by then almost established a monopoly on the Melaka pepper trade with the western shores of the Indian Ocean, a forewarning of their role at Aceh later in the sixteenth century. Chinese shippers took a growing share in the overseas trade of the emerging Banten sultanate. By the end of the sixteenth century, we are therefore witness to a radical disengagement of local shippers from the lucrative overseas activities in which they had earlier competed at par with Tamil, Gujarati or Chinese merchants. By then, as a consequence, the large *jong* described in the early sixteenth century appear to have practically vanished, leaving the field open to Gujarati *naos* and Chinese-owned junks.[60]

The South China Sea Tradition

Surprisingly enough, the comparatively extensive archaeological researches carried out in Southeast Asia have so far failed to bring to light significant remains of the large plank and frame-dowelled Malay World *jong*. On the contrary, the totality of the 15 or so properly recorded fourteenth to seventeenth-century large shipwrecks excavated in the past decades in Southeast Asian waters had their planks fastened to the ribs with square iron nails, and had their holds separated into compartments by strong wooden bulkheads, both features that were until recently associated only with Chinese ship-building. Many other prominent features of these vessels, however, remain within the Southeast Asian tradition: their planks were fastened together with dowels, they had a V-shaped, double-ended hull with a keel, and their timbers were usually of tropical origin.[61] There is thus no possible confusion with shipwrecks of vessels conventionally identified as (northern) Chinese 'junks', which would have had flat bottoms, no keel, no frames (only water-tight bulkheads), transom stern and stem, would have been built out of pine or fir wood, and would have its planks fastened with iron nails or clamps

(Chinese shipwrights are said to have exclusively made use of iron nails and clamps as early as the third century CE).

A close comparison between the evidence drawn from these shipwrecks (as well as from those found in Southern China) and from what is known of the 'pure' Southeast Asian and Chinese traditions has given birth to an additional class of vessels, prominent so far in archaeological sites only: this group of ships would have belonged to a hybrid tradition of ship-building which I have termed the 'South China Sea tradition'.[62]

A flexible combination of (Northern) Chinese and Southeast Asian features may indeed be found in most such thirteenth to seventeenth-century shipwrecks found so far in Southeast Asian and Southern Chinese waters. Various factors may have intervened to give birth to such a tradition. It is possible that Southeast Asian techniques evolved in earlier times, for high-seas navigation would have been adopted and adapted by the Chinese when they started developing their own high-seas navy at the beginning of the second millennium CE. It is more than probable, though, that further cross-influences took place in a more radical way when Chinese overseas traders and ship-builders started settling in Southeast Asian harbours under the Ming dynasty, when they were banned from building large ships in their home country by renewed closed-policy imperial decrees, and consequently started building their own ships in tropical areas. It is quite possible that most of these ships were then used by the overseas Chinese, and from the evidence presently available, they would have mostly carried cargoes of Thai ceramics (which largely replaced China-made ceramics in Southeast Asian markets at that time). The shipwrecks belonging to this South China Sea tradition have so far been found in the Gulf of Siam, in the strait of Singapore, in the Philippines, in Vietnam and in Southern China.[63]

Indeed, no mention is made of iron-fastened *juncos* sailing into the Bay of Bengal in Portuguese sources, and the Chinese 'junks' described by Marco Polo and Ibn Battuta in Indian Ocean waters in the fourteenth century do appear to have belonged to the 'pure' Chinese tradition.[64] These scanty records are, however, not sufficient to prove beyond doubt that the vessels belonging to the South China Sea tradition did not sail into the Bay of Bengal, in the hands of Southeast Asian merchants or of their Tamil and Bengali colleagues based in Melaka, leaving Indian Ocean waters to vessels of pure Southeast Asian build.

SHIP-BUILDING IN THE MALDIVES

The Maldives islands pose specific questions. They lie not far south of the Indian subcontinent, with which its population shares many cultural traits (including language); on the other hand, they rest astride the southernmost sea routes across the Indian Ocean, half way between Indonesia and Madagascar (an island peopled by Austronesian speakers originating from Southeast Asia). Probably because of their privileged position in the middle of a vast expanse of sea, and despite their seemingly isolated position south of the major trans-Asian sea route running along the 6´North parallel, the Maldivian archipelago attracted a lot of attention from late medieval and modern writers. Some of their descriptions carry fine details on ship-building.

Ma Huan, a secretary to Admiral Zheng He, who visited the islands in 1413 and 1421, provided us with a clear description of the ships he saw being built there: 'They never use nails; they merely bore the holes, and always use their [coir] ropes to bind [the planks] together, employing wooden pegs in addition'. The early sixteenth-century Chinese description found in the *Xiyang chaogong dianlu* states that: 'When building boats, they do not use wrought iron [to clamp them], but take coconut fibre cord to tie and link [the planks], employing [wooden] dowels [as well]; and they use ambergris, smelt it, and lute [the hull]'.[65]

The Portuguese chronicler Gaspar Correa describes Maldivian craft of 1503 in similar terms: 'They were made of coconut-tree timber assembled with wooden pegs, without any [iron] nails'. Barbosa, slightly later in the sixteenth century, elaborated on the fact that Maldivians '(...) build many great ships of palm trunks, sewn together with thread, for they have no other timber'.[66]

Except for one essential feature, these descriptions are supported by the observation of the *dhoni*s that were still being built in the Maldives a few years ago.[67] Treenails were then still in use to assemble hull planks made out of coconut timber, the only one available there in any quantity (only the keel-piece was made of harder mangrove wood). But how is one to account for the sewn (or stitched) planks two of these authors refer to? Rivets are now always used, and nobody in the Maldives appears to remember seeing or even hearing of sewing, stitching, or lashing of planks and other structural elements in local boats. However, the word used in Divehi to describe the action of building a boat is *banun*, which literally means 'tying together' or 'binding (with a rope)'. The prolonged usage of this specific term, with distinct technical implications, in the ship-building world of the Maldives does hint at the existence of an earlier fastening (sewing or stitching) tradition. Ropes are still all made of coconut coir and remain, as in the past, a characteristic product of the region (the fabrication and sales of which are in the hands of women).

A careful observation of surviving structural details of the older *dhoni*s and of building procedures in traditional shipyards further allowed us to unequivocally classify the Maldivian ship-building tradition as Southeast Asian (differences in contemporary techniques can easily be explained by independent evolutions during the past centuries). The survival of lugs carved out of the interior of the side-planks on which the structurally essential thwarts (cross-beams) rest, the compression procedures used during the shell-first building process, and even the modern use of rivets (rather than nails) point towards an affiliation with the lashed-lug and stitched-plank tradition indigenous to Southeast Asia, and cannot be reconciled with the features of sewn-plank ships of the Arabo-Indian tradition. The recent excavation of the Kadakkarapally boat in Kerala appears to strengthen the southern India-Southeast Asia link in ship-building traditions.[68]

As far as I can ascertain, there are two possible explanations for such close similarities between Southeast Asian and Maldivian traditions. The Maldivian techniques could have been introduced by Austronesian-speaking shippers of Insular Southeast Asia, who were still regular visitors to the archipelago in the early sixteenth century, either on a trade circuit to and from the Maldives or on their way to the western half of the Indian Ocean, and specifically to Madagascar. It is also possible that both the Maldivian tradition and that of Insular Southeast Asia would have belonged to one single broader tradition that would earlier have encompassed all the eastern part of the Indian Ocean, including, possibly, the Southern and Eastern coasts of India, as discussed earlier in this chapter, an hypothesis based on a shared thesaurus of nautical terms on both sides of the Bay of Bengal, and on superficial observations of similarities in hull forms. At this stage, with an almost total lack of information on structural details of Bay of Bengal hulls from the Indian side, it is impossible to ascertain which one of the two explanations is correct (or we may have a combination of the two, since they are not mutually exclusive).

CONCLUSIONS

Various authors have divided the ships plying Asian waters during late medieval times into two to three main classes only. In 1939, W.H. Moreland wrote of 'two different types of seagoing vessels in the Asiatic Seas, the strongly built, iron-fastened junks of China, and the frail stitched ships of the Arabian Sea'. He found no evidence to suggest that the latter were not exclusively built on the west coast of India, from Surat to Cochin. K.N. Chaudhuri mentioned three main regional groups: the 'Indo-Islamic tradition of shipbuilding' was that of the Indian Ocean as far west as Bengal; the deep-sea carrier '*par excellence* in the Indonesian archipelago and the Far East was the Chinese *junk*'. He dismisses Southeast Asian ships as a third group of light and fast boats, improperly classified as 'perahu and sampan types', which he confines to regional routes.[69] We have seen how such a derogatory statement is far from the textual evidence already available in the 1980s. Archibald Lewis also wrote in 1973 about 'two sorts of vessels which engaged in long-standing Indian design and which were built along both the western and eastern shores of this subcontinent, as well as along East African coasts and in the Red Sea, South Arabian, and Persian Gulf ports, and those built in Chinese-Southeast Asian style which were known as *junks'*. Archibald Lewis' thorough reading of the Portuguese sources available to him had thus led him as early as 1973 to describe the second group as an ambiguous 'Chinese-Southeast Asian' class, mainly used by Southeast Asians, but the use of which was starting to spread among Coromandel and Bengal merchants. A the time he wrote, though, the true Southeast Asian traditions for building large sea-going ships had not been properly identified by historians and archaeologists, and he was not able to fully elaborate on the matter.

The preceding pages will have made it clear that I am in broad agreement only with A. Lewis' classification, although I cannot follow him in detailed interpretations within the main classes of vessels. Considering the evidence at hand, I have stated earlier that it was almost impossible to precisely indicate the area in which a ship was built following the skimpy indications of ancient or medieval texts. Regarding the Arabian Sea vessels, there is no more evidence to point only to the west coast of India (as Moreland or Lewis would have it) than there is for or against places further west in the Indian Ocean. Nor can one pronounce this class of sewn vessels a 'long-standing Indian design', as did Lewis. As pointed out before, this dhow-type class seems to differ quite radically from Indian ships of earlier periods, or at least from the little we know of them. There is no way as yet to date with any precision the development and spread of the dhow-type class of ships that I called, for lack of a better term, the 'Arabo-Indian shipbuilding tradition'. It seems at first sight to have taken place around the thirteenth and fourteenth century, but this is also the time when exploitable sources are first available. Earlier sources date from the middle of the first millennium CE, and this leaves us with an unaccounted for gap of a few centuries.

However, considering the area of diffusion of this 'Arabo-Indian tradition' from late medieval times onwards, and considering also the fact that it appears to have been principally associated with Islamic merchant communities and that its development may be roughly estimated to have taken place at a period when the Islamic trading networks were reshaping the Indian Ocean economic scene, it seems justified at this stage to hypothesize an Arabic or Persian origin for this tradition. The adoption of the central rudder almost simultaneously in the Mediterranean and in the western half of the Indian Ocean around the twelfth and thirteenth centuries certainly does point towards a Middle Eastern origin. The lateen rig, as seen earlier, may well have followed the same route, but at a much later time than thought until now. Whichever its origin, this Arabo-Indian tradition does appear to have encompassed the western half of the Indian Ocean and given it, by the fifteenth century, a unified image (making some inroads into the Bay of Bengal). The relationship between the Gujarati and Arabo-Indian tradition is not clear from the available evidence. It is tempting to consider the former a largely indigenous Indian development, if only because of the apparent difference in the shape of the hulls and the unique *vadhera* rabbetting process.

This is no place to discuss at length the genesis of the ancient Indian ship-building traditions and its relationship with those of neighbouring areas east and west of the Indian Ocean. Suffice it to say that it has been thought to be influenced by Mediterranean techniques but that, in the present state of our knowledge, one could say just as much for influences from the eastern half of the Ocean. After all, Austronesian-speaking people did sail all the way to Madagascar across this Ocean and along its shores during some 15 centuries: the diffusion of the smaller outrigger canoes on Indian coasts also bears testimony to such cross-influences.[70]

As for the Bay of Bengal, it remains as yet very much of a *mare incognitum*. The close links established between its eastern and western shores from at least the last few centuries BCE, the continuous economic and cultural interchange that took place until the period of our concern, all point towards the evolving of some measure of technical unity in ship-building traditions. The linguistic evidence gathered from a shared terminology further confirms this. However, the late testimonies of the usage of *juncos* by merchants of Coromandel and Bengal could, and most probably should, be understood in a narrower perspective, that is, the mere geographical proximity of Bengal and Pegu and the settling of thriving Coromandel and Bengali trading communities in Southeast Asian harbour cities. The present imbalance of our knowledge in favour of Southeast Asian techniques does not facilitate the appraisal of the situation for lack of comparable evidence across the Bay.

Faced with the scantiness of tangible data to work on (with the exception of Southeast Asian ships), we have, like our predecessors, tried to identify general trends of the Indian Ocean maritime scene and isolate the broad technological traditions at play in the early modern Indian Ocean, at the risk of neglecting the study of regional singularities and the contribution of this or that specific ethnic group in shaping the overall scene. One must not forget, however, that sea-going, long-distance trading ships and their crews kept in touch with a broad variety of social and technological milieus, and were confronted over the centuries with a variety of historical *conjonctures* which are known to have given them at times no other choice than to adopt foreign technologies. The common usage of some nautical terminology confirms the existence, some 2,000 years ago, of such a cosmopolitan environment. Nautical terms, however, may travel considerable distances at a pace that is not necessarily that of the original artefact or process they describe. One should also keep in mind that the rigging of a ship may at times be from a different origin than the hull structure (a good example is that of the Bugis *pinisi*, which sported in the twentieth century a European pinnace rig—hence its Indonesian name—on a purely Southeast Asian dowelled hull). In the words of Sanjay Subrahmanyam, one should challenge 'the view that the Asian societies of the early modern era were inflexible in the face of opportunity'. Ashin Das Gupta also insisted on the complexity of these trade-oriented, cosmopolitan, socio-economic environments.[71]

To say that much remains to be done in these areas of investigation is a truism. Ethnographic research among maritime-oriented communities should continue to be made an absolute priority: their traditional culture is disappearing at a fast pace. Technical aspects of their culture dealing with ship-building or navigational skills should be recorded and investigated in connection with closely associated aspects of the economics of their seafaring activities and social organization.[72] Textual and archival research should also be carried out to locate more written documents with precise descriptions of ship structures. Last but not least, large-scale archaeological surveys followed by the systematic study of sites with ship remains should be carried out in the whole Indian Ocean. Priority should now be given to the so far neglected Asian vessels, for which practically no other source is available. Environmental conditions may not be as favourable on Indian coasts as they are in the often shallow and protected seas of Southeast Asia, but the dramatic progress in maritime history brought forth by nautical archaeologists in the Western world and, to a lesser extent, in Southeast Asia, could nevertheless be matched in Indian Ocean waters.

NOTES AND REFERENCES

1. Chinese ships were not built on Indian Ocean shores or neighbouring seas, and will therefore not be dealt with in any detail in this chapter. With the exception of the Zheng He episode in the early fifteenth century, Chinese shipping in early modern times was hampered by the so-called 'Ming ban' on foreign voyages. Only hybrid China–Southeast Asia ships will be dealt with further down in this chapter.
2. A. Das Gupta, 1986, 'Asian Shipping: A Note', *Indian Ocean Newsletter,* 7 (1), pp. 12–13.
3. F.C. Lane, 1979 1934, *Venetian ships and shipbuilders of the Renaissance*, New York, p. 2.
4. Michael Flecker, 2000, 'A 9th-century Arab or Indian shipwreck in Indonesian waters', *International Journal of Nautical Archaeology,* 29 (2), pp. 199–217; and 'A Ninth-century Arab or Indian shipwreck in Indonesian waters', *World Archaeology,* 32 (3), 2001, pp. 335–54; personal communication, 2007.

5. R.K. Pedersen, 2004, 'The Shipwreck at Coconut Grove: The Kadakkarapally Boat', *Institute of Nautical Archaeology Quarterly,* 31 (2), pp. 3–9; V. Tomalin, V. Selvakumar, M.V. Nair, et al., 2004, 'The Thaikkal-Kadakkarapally Boat: An Archaeological Example of Medieval Shipbuilding in the Western Indian Ocean', *International Journal of Historical Archaeology,* 33 (2), pp. 253–63. A late prehistoric log boat found near Colombo would constitute the only other archaeological site with ship remains to be reported on (in S. McGrail, 2003, *Boats of South Asia*, London, p. 14).
6. A recent set of essays on late pre-historic and early historic Southeast Asia was published by P. Bellwood and I.C. Glover (eds), 2004, *Southeast Asia: From Prehistory to History,* London, among which, see specifically that by P.-Y. Manguin, which deals with early maritime states and exchange ('The Archaeology of the Early Maritime polities of Southeast Asia', pp. 282–313).
7. The hijack of one of the finest iconographic representations of Asian ships on the late eighth-century Borobudur stupa reliefs provides a good example of this biased attitude. These unequivocally Malay World ships are too often considered by Indian authors to represent Indian ships (usually repeating R.K. Mookerji, who published his major work in 1912, at a time when the role of Southeast Asian shippers and shipbuilders could not be understood). The Borobudur ships reappeared on the cover illustration of the 1957 reprint of Mookerji's major work (*Indian Shipping. A History of the Sea-Borne Trade and Maritime Activities of the Indians from the Earliest,* Bombay, 1957). More recently, see, among others, S. Tripati, 2000, *Maritime archaeology: Historical descriptions of the seafarings of the Kalingas,* New Delhi, for a rehash of this invalid cliché.
8. For practical purposes, I have used the word *dhow* in the modern Anglo-Indian sense, that is, any vessel belonging to this broad category of Arabo-Indian craft. Except possibly in Nikitin's travelogue of 1495–96, it seems to have been used only after the eighteenth century (R.H. Major [ed.], 1857, *India in the Fifteenth Century*, London, pp. 8, 30; see also H. Yule and A.C. Burnell, 1903, *Hobson-Jobson. A Glossary of Colloquial Anglo-Indian Words and Phrases*, London, *s.v. dhow*).
9. Gaspar Correa, 1858–66, *Lendas da Índia*, Lisboa, Vol. I/1, pp. 12–124. The English word *coir* was adapted after the sixteenth-century Portuguese form *cairo* (*Hobson-Jobson*, s.v. coir).
10. To be more precise, the term found in Correa's text (*Lendas da Índia,* Vol. I/1, p. 122) is *liames*, which is used for all the structural components of a ship, such as keel, stem and stern posts, frames, etc., that is, the skeleton on which the planks rest. But the fact that he insists on how few these were and that they were stitched to the planks can only be understood as meaning that Correa was referring to frames.
11. W.H. Moreland, 1939, 'The Ships of the Arabian Sea about 1500 A.D.', *Journal of the Royal Asiatic Society*, pp. 65–66.
12. Marco Polo's text, as reconstructed by A.C. Moule (A.C. Moule and P. Pelliot [eds], 1938, *Marco Polo. The description of the World*, London, Vol. I, p. 37). See also the fifteenth-century Portuguese translation of a Latin original, which clearly mentions dowels (*tornos de pao*; F.M.E. Pereira [ed.], 1922, *Marco Paulo. O Livro de Marco Polo. O Livro de Nicolao Veneto. Carta de Jeronimo de Santo Estevão*, Lisboa, p. 8v.). W.H. Moreland rejects Polo's evidence on dubious grounds ('The ships ...', p. 68).
13. Damião de Gois, 1926, *Crónica do Felicíssimo Rei D. Manuel*, Lisboa, Vol. I, pp. 74, 126. As a comparison for the progressive introduction of dowels in stitched-plank craft of Southeast Asia at an earlier period, see P.-Y. Manguin, 1985, 'Sewn-plank Craft of South-East Asia. A Preliminary Survey', in S. McGrail and E. Kentley (eds), *Sewn Planked Boats. Archaeological and Ethnographic papers based on those presented to a conference at Greenwich in November, 1984*, Oxford, BAR International Series 276, pp. 319–43, and 'Southeast Asian shipping in the Indian Ocean during the 1st millennium AD', in H. P. Ray and J.-F. Salles (eds), *Tradition and archaeology. Early maritime contacts in the Indian Ocean*, Lyon, New Delhi, 1996, pp. 181–98.
14. E.B. Martin, 1982, 'The present-day Dhow Trade of India', *Great Circle*, 4 (2), p. 118.
15. On the 'designed flexibility' of sewn plank ships, see R.M. Adams, 1985, 'Designed Flexibility in a Sewn Boat of the Western Indian Ocean', in S. McGrail and E. Kentley (eds), *Sewn Plank*

Boats, pp. 289–302; E. Rieth and A. Simon, 1991, 'La construction traditionnelle d'un "banoosh" de Bahrain', *Neptunia,* 183 (3), pp. 37–42; T. Severin, 1982, *The Sindbad Voyage*, London, and 'Construction of the Omani Boom Sohar', in S. McGrail and E. Kentley (eds)*, Sewn Plank Boats,* pp. 279–87.

16. A. Jan Qaisar, 1968, 'Shipbuilding in the Mughal Empire during the Seventeenth Century', *Indian Economic and Social History Review,* 5 (2), p. 150, and *The Indian Response to European Technology and Culture (A.D. 1498–1707)*, Delhi, 1982, pp. 20–23. For a precise definition of 'luting', see B. Greenhill, 1976, *Archaeology of the Boat*, London, p. 74.
17. J.V.G. Mills (ed.), 1970, *Ma Huan. Ying Yai Sheng Lan. 'The overall Survey of the Ocean's Shores' (1433)*, Cambridge, pp. 111, 149 (Ma Huan refers to ships of Melaka and the Maldives); W.B. Greenlee (ed.), 1938, *The Voyage of Pedro Alvares Cabral to Brazil and India*, London, p. 65; Fernão Lopes de Castanheda, 1924–33, *História do descobrimento e conquista da Índia pelos Portugueses*, Coimbra, Vol. I, xxxiii, p. 75 (for Arabian ships); Correa, *Lendas da Índia,* Vol. I/1, p. 123 (for ships at Cannanore); *Hobson-Jobson*, s.v. *kil* and *damar*.
18. *Hobson-Jobson*, s.v. kil.
19. *Hobson-Jobson*, s.v. *gallegalle*; J. Gonda, 1973, *Sanskrit in Indonesia*, New Delhi, pp. 93, 324 (the word may be derived from the Sanskrit *gala*, resin); Castanheda used it for a ship at Melaka in 1511 (*História do descobrimento* ..., II, cxii, p. 459). I have personally heard the term used in places as remote as Goa, the Philippines, Borneo or Celebes.
20. T.M. Johnstone and J. Muir, 1962, 'Portuguese influences on Shipbuilding in the Persian Gulf', *Mariner's Mirror*, 48, p. 60.
21. Correa, *Lendas da Índia*, I/1, p. 122; J. Deloche, 1983, 'Le bateau de Tirupputaimarutur (Sud de l'Inde)', *Bulletin de l'Ecole française d'Extrême-Orient,* 72, pp. 1–12 (which also has the al-Hariri illustration); G.F. Hourani, 1951, *Arab Seafaring in the Indian Ocean in Ancient and Early Mediaeval Times*, Princeton, pl. 7; A. Cortesão and A. Teixeira da Mota, 1960, *Portugaliae Monumenta Cartographica*, Lisboa, Vol. II, p. 21; the best illustrations of modern dhows will be found in Hawkins 1977.
22. Correa, Lendas da Índia, Vol. I/1, p. 122; G.R. Tibbetts, 1972, *Arab Navigation in the Indian Ocean before the Coming of the Portuguese*, London, p. 51.
23. Moule and Pelliot (eds), *Marco Polo*, Vol. I, p. 37; William W. Rockhill, 1915, 'Notes on the Relations and Trade of China with the Eastern Archipelago and the Coast of the Indian Ocean during the Fourteenth Century', *T'oung pao,* 16, p. 623; Deloche, 'Le bateau de Tirupputaimarutur'.
24. J. Hornell, 1946, 'The Sailing Craft of Western India', *Mariner's Mirror*, 32, p. 207.
25. M.L. Dames (ed.), 1918, *The book of Duarte Barbosa*, London, Vol. I, p. 27, Vol. II, p. 76; W.B. Greenlee (ed.), *The Voyage of Pedro Alvares Cabral*, p. 65.
26. Personal observations, 1971; an illustration of this hero-stone was made by K.S. Ramachandran in 1970, on which this rudder is clearly visible ('Ancient Indian Maritime Ventures', in *India's Contribution to World Thought and Culture*, Madras, 1970, pp. 71–80). J. Deloche published a study of these hero-stones in 1987 ('Konkan Warships of the XIth–XVth Centuries as Represented on Memorial Stones', *Bulletin de l'Ecole française d'Extrême-Orient,* 76, 1987, pp. 165–84); they have recently been published again by Sila Tripati, who does not delve into the steering gear evidence they provide and ignores earlier publications (Sila Tripati, 2006, 'Ships on Hero Stones from the West Coast of India', *International Journal of Historical Archaeology,* 35 (1), pp. 88–96).
27. Hourani, *Arab seafaring*, pl. 7; J. Deloche, 'Le bateau de Tirupputaimarutur ...', pl. Va.
28. H. Yule and H. Cordier (eds), 1913–16, *Cathay and the way Thiter*, London, Vol. III, pp. 66–67.
29. The whole passage reads: 'Hanno il timone legato con corde e piu lungo che la ruota della nave circa di 6 1/2 dei nostri'. The last words are not clear, and the copy is probably corrupt. The complete text of this letter from the Codex Riccardiano no.1910 remains unpublished; see C.M. Radulet, L.F. Thomaz and M.E. Madeira Santos, 1985, 'Fontes italianas para a historia das viagens à Índia (1499–1506)', Paper presented at the *IV*th *International Seminar on Indo-Portuguese*

History, Lisboa (I wish to thank Carmen Radulet for having kindly provided me with transcripts of the relevant passages of this and other letters from this codex).

30. Correa, *Lendas da Índia*, Vol. I/1, p. 123.
31. Hourani (*Arab seafaring*, pp. 98–99) was the first to note the simultaneous appearance of the single rudder in the Mediterranean and in the Indian Ocean during the early thirteenth century. Further discussions of the rudder problem will be found in Johnstone and Muir, 'Portuguese influences ...'; R. LeBaron Bowen, 1963, 'Early Arab Ships and Anchors', *Mariner's Mirror*, 49 (4), pp. 303–04; Tibbetts, *Arab Navigation* ..., pp. 54–55; and Needham, *Civil Engineering and Nautics* , pp. 635–38); the use of *kana* in Arabic and Tamil is mentioned, respectively, by Johnstone and Muir, 'Portuguese influences ...', and by V.F.C. Nadarajah, 1968, 'A Survey of Nautical Terms in Tamil', in *Proceedings of the 1st Conference Seminar of Tamil Studies*, Kuala Lumpur, Vol. I, p. 552.
32. See R.K. Mookerji, 1957, *Indian Shipping. A History of the Sea-Borne Trade and Maritime Activities of the Indians from the Earliest*, Bombay, Chap. II; L. Gopal, 1962, 'Art of Shipbuilding and Navigation in Ancient India', *Journal of Indian History*, 40 (2), pp. 313–27; and the exhaustive analysis of data on ancient ships by D. Schlingloff, 1982, 'Indische Seefahrt in Romischer Zeit', in H. Muller-Karpe, *Zur Geschichtlichen Bedeutung der fruhen Seefahrt*, Munchen, pp. 51–85, and *Studies in the Ajanta Paintings: Identifications and Interpretations*, New Delhi, 1987.
33. Tibbetts, *Arab Navigation* ..., p. 52.
34. *Diário da viagem de Vasco da Gama,* Porto, 1945, Vol. I, p. 36; Yule and Cordier, *Cathay and the way Thiter*, Vol. III, pp. 66–67; Dames (ed.), *The Book of Duarte Barbosa,* Vol. I, pp. 27, 107; see also A. Moore for modern dhow sails ('Notes on "dhows"', *Mariner's Mirror*, 26, 1940, pp. 205–13), and A.H.J. Prins for those of the *mtepe* of Lamu ('The *Mtepe* of Lamu, Mombasa and the Zanzibar Sea', *Paideuma*, 28, 1982, pp. 87–100).
35. Schlingloff, *Indische Seefahrt* ...; Hourani, *Arab Seafaring* , pp. 100–01 and pl. 7; Deloche, 'Le bateau de Tirupputaimarutur ...'; J. Hornell, 1920, 'The Origins and Ethnological Significance of Indian Boat Designs', *Memoirs of the Asiatic Society of Bengal*, 7 (3), p. 180.
36. Correa, *Lendas da Índia*, Vol. I/1, pp. 123–24; Tibbetts, *Arab navigation* ..., p. 52; Cortesão and Teixeira da Mota, *Portugaliae monumenta cartographica*, Vol. I, pp. 19, 21 (in the 1519 Portuguese atlas, the Muslim ships sport a crescent on their sails; contrary to all written sources, though, two masts are usually depicted).
37. For a discussion of the evolution of the lateen, see, among many others, I.C. Campbell, 1995, 'The Lateen Sail in World History', *Journal of World History*, 6 (1), pp. 1–23; J. Needham, *Civil Engineering and Nautics*, pp. 605–17, defending a Southeast Asian origin, or P. Adam, 1970, 'A propos des origines de la voile latine', in *Mediterranée et Oćean Indien, Travaux du 6^e^ colloque international d'histoire maritime,* Paris, pp. 203–29, for a Mediterranean one, and the references quoted in these studies.
38. A. Cortesão (ed.), 1944, *The Suma Oriental of Tomé Pires*, London, Vol. I, p. 45; Castanheda, *História do descobrimento* ..., II/lx, p. 341, VIII/xlix, pp. 279–80; see also W.H. Moreland, 'The Ships of the Arabian Sea ...', who calls the great ships of the ruler of Gujarat 'the leviatan of the Arabian Sea'; M.N. Pearson, 1976, *Merchants and Rulers in Gujarat. The Response to the Portuguese in the Sixteenth Century*, New Delhi, p. 8, and the sources quoted therein.
39. Greenlee (ed.), *The Voyage of Pedro Alvares Cabral* ..., p. 65; Castanheda, *História do descobrimento*..., III/cxxx, p. 315.
40. J. Deloche, 1978, 'Techniques anciennes de constructions navales en Inde: le problème de la liaison des bordages (sources et méthodes)', in *VIth European Conference on Modern South Asian Studies*, Paris; J. Hornell, 1930, 'The Tongue and Groove Seam of Gujarati Boatbuilders', *Mariner's Mirror*, 16 (4), pp. 309–12.
41. A. Jan Qaisar, 'Shipbuilding in the Mughal Empire ...', and *The Indian Response*..., pp. 20–26.
42. P. Giudici (ed.), 1928, *Itinerario di Ludovico de Varthema*, Milano (Viaggi e scoperte di navigatori ed esploratori italiani, 2), p. 219; Castanheda, *História do descobrimento* ..., III/xi, p. 26; Correa, *Lendas da Índia*, I/1, p. 122; Moreland, 'The Ships of the Arabian Sea ...', pp. 181–82.

43. Greenlee (ed.), *The Voyage of Pedro Alvares Cabral* ..., p. 105.
44. Qaisar, *The Indian Response* ..., p. 22; Hornell, 'The Origins ...', p. 145.
45. This paucity had already in 1939 prevented W.H. Moreland from extending his study to vessels of the Bay of Bengal ('The Ships of the Arabian Sea ...').
46. See S. Subrahmanyam, 1990, *A presença portuguesa e o comércio de Coromandel (Secs. XVI e XVII)*, Lisboa, p. 5, and the sources quoted therein. He also discussed the rebirth of a ship-building industry at Narsapur Peta in the seventeenth century ('A Note on Narsapur Peta—A "Syncretic" Shipbuilding Centre, 1570–1700', *Journal of the Economic and Social History of the Orient,* 31 (3), 1988, pp. 305–11). For the publication of the fresco, see Deloche, 'Le bateau de Tirupputaimarutur ...'.
47. R.A.L.H. Gunawardana, 1987, 'Changing patterns of navigation in the Indian Ocean and their impact on Pre-Colonial Sri Lanka', in Satish Chandra (ed.), *The Indian Ocean: Explorations in History, Commerce and Politics,* New Delhi, p. 88; Cortesão (ed.), *The Suma oriental* ..., p. 87.
48. Hornell, 'The Origins ...', pp. 162–69, 178–82; E. Kentley, 1985, 'Some Aspect of the Masula Surf Boat', in S. McGrail and E. Kentley (eds), *Sewn Plank Boats*, pp. 303–17; E. Kentley and R. Gunaratne, 1987, 'The madel paruma: A sewn boat with chine strakes', *International Journal of Nautical Archaeology,* 16 (1), pp. 35–48.
49. Jeremy Green relies on the model of a Sri Lankan *yatra dhoni* in the Maritime Museum in Galle, and goes as far as suggesting that this vessel is a derivative of those illustrated on the Borobudur reliefs ('The archaeological contribute to the knowledge of the extra-European shipbuilding at the time of Medieval and Modern Iberian-Atlantic tradition', in F. Alves [ed.], *Proceedings, International Symposium on Archaeology of Medieval and Modern ships of Iberian-Atlantic tradition, Work Sessions*, Lisboa, 2001, p. 79). See also the work of S. Devendra, who divides ships observed in Sri Lanka between the Arab and Bay of Bengal traditions, the latter sharing characteristics with the Southeast Asian tradition ('Ships and shipbuilding traditions of the Indian Ocean as preserved in Sri Lanka', *Indian Ocean Review,* 3 (3), 1990, pp. 2–5, and 'Pre-Modern Sri Lankan Ships', in D. Parkin and R. Barnes (eds), *Ships and the Development of Maritime Technology in the Indian Ocean*, London, 2002, pp. 128–73.
50. References to these various words will be found in T. Burrow and M.B. Emeneau, 1984, *A Dravidian Etymological Dictionary*, Oxford, nos 1219, 3838, 4120; and in the *Tamil Lexicon*, Madras, 1982, 7 vols, s.v. *vankam.* See also G. Kulathuran and V.S. Arul Raj, 1987, *History of Traditional Navigation, as Gleaned from Tamil Literature*, New Delhi (Report submitted to the National Institute of Science, Technology and Development Studies, C.S.I.R.), Vol. III), pp. 6, 9; C. Siva Shanmugam, 1987, *History of Traditional Navigation, as Gleaned from Kannada Literature,* New Delhi (Report submitted to the National Institute of Science, Technology and Development Studies, C.S.I.R.), Vol. II; V.S. Arul Raj, 1987, *History of Traditional Navigation, as Gleaned from Malayalam Literature*, Thanjavur (Report submitted to the National Institute of Science, Technology and Development Studies, C.S.I.R., New Delhi), Vol. I; S. Paranavitana, 1966, *Ceylon and Malaysia*, Colombo, p. 210; V.F.C. Nadarajah, 1968, 'A Survey of Nautical Terms in Tamil', in *Proceedings of the 1st Conference Seminar of Tamil Studies*, Kuala Lumpur, Vol. I, p. 548; N.K. Panikkar and T.M. Srinivasan, 1972, '*Kapal Sattiram.* A Tamil Treatise on Shipbuilding during the Seventeenth Century', *Indian Journal of Historical Science*, 7, p. 21; F.B.J. Kuiper, 1962, 'A Malay word in Tamil', *Indo-Iranian Journal,* 5 (3), pp. 237–41; Ph. S. van Ronkel, 1902, 'Het Tamil-element in het Maleisch', *Tijdschrift voor Indische taal-, land- en volkenkunde uitgegeven door het Bataviaasch Genootschap van Kunsten en Wetenschappen,* 45, pp. 97–119; A. Pawley and M. Pawley, 1998, 'Canoes and seafaring', in M. Ross, A. Pawley and M. Osmond (eds), *The Lexicon of Proto Oceanic. Vol. 1: Material Culture,* Canberra, Research School of Pacific Studies, (Pacific Linguistics C152), pp. 173–209; Waruno Mahdi, 1999, 'The dispersal of Austronesian boat forms in the Indian Ocean', in R. Blench and M. Spriggs (eds), *Archaeology and Language, III. Artefacts, Languages and texts,* London, New York, pp. 144–79. A good example of the word *kapal* with a clear foreign connotation can be found in a 1522 Malay letter by the Sultan of Ternate, where

it is used for Spanish vessels (O. Blagden, 1930, 'Two Malay Letters from Ternate in the Moluccas written in 1521 and 1522', *Bulletin of the School of Oriental and African Studies*, 6 [1], p. 96). Varthema mentions *paraos* ('small boats') and *capels* ('made in our fashion') at Calicut in 1505 (in Giudici (ed.), *Itinerario* ..., p. 221).

51. S. Gupta, 2005, 'The Bay of Bengal interaction sphere (1000 BC–AD 500)', *Bulletin of the Indo-Pacific Prehistory Association,* 25, pp. 21–30.
52. Cortesão (ed.), *The Suma oriental...,* Vol. I, p. 88; Dames (ed.), *The Book of Duarte Barbosa*, Vol. II, pp. 143–45. The 1527 letter can be found in the Arquivo Nacional da Torre do Tombo (CC. III–9–94). S. Subrahmanyam has hypothesized the seventeenth-century development of another hybrid ship-building tradition at Narsapur Peta, which combined earlier characteristics of the 'naos mauriscas' with European features ('A Note on Narsapur Peta ...').
53. B. Greenhill, 1957, 'The Boats of East Pakistan a Preliminary Study', *Mariner's Mirror,* 43 (2, 3), pp. 106–34, 203–15, and Greenhill, 1971, *Boats and Boatmen of Pakistan*, Newton Abbot; J. Deloche, 1980, *La circulation en Inde avant la révolution des transports, Tome II: La voie d'eau*, Paris, pp. 166–72; S. McGrail (ed.), 2003, *Boats of South Asia*, London, and *Boats of the World: from the Stone Age to Medieval Times*, Oxford, 2001, pp. 269–78. It is tempting to see a connection between the Bengali term *jhong* and the Malay *jong*, despite the fact that the former is nowadays exclusively used for large upriver craft of the Ganges. On the Southeast Asian *jong*, see below.
54. In this chapter, we have most often used the inclusive term 'Southeast Asia' so as not to eliminate little known but potential ship-building areas (such as the Mon of Pegu, in what is now southern Myanmar). The Austronesian-speaking peoples and their ancient seafaring culture, however, do appear to have dominated the South China Sea, at least as far as seafaring is concerned.
55. On surviving lashed-lug plank-built boats of Southeast Asia, see R.H. Barnes, 1985, 'Whaling Vessels of Indonesia', in S. McGrail and E. Kentley (eds), *Sewn Plank Boats*, pp. 345–66, and 'Yami Boats and Boat Building in a Wider Perspective', in D. Parkin and R. Barnes (eds), *Ships and the Development of Maritime Technology in the Indian Ocean*, London, 2002, pp. 291–314; A. Horridge, 1982, *The Lashed-lug boats of the Eastern Archipelagoes, the Alcina MS and the Lomblen Whaling boats*, Greenwich. On similar ancient ships from archaeological contexts, see works by P. Clark, J. Green, R. Santiago, T. Vosmer,, 1993, 'The Butuan Two boat known as *balangay* in the National Museum, Manila, Philippines', *International Journal of Nautical Archaeology,* 22 (2), pp. 143–59, and by P.-Y. Manguin, 1980, 'The Southeast Asian Ship. An Historical Approach', *Journal of Southeast Asian Studies,* 11 (2), pp. 266–76; 'Sewn-plank Craft of South-East Asia. A Preliminary Survey', in S. McGrail and E. Kentley (eds), *Sewn Planked Boats,* pp. 319–43; 'The trading ships of Insular Southeast Asia: New evidence from Indonesian archaeological sites', in *Proceedings, Pertemuan Ilmiah Arkeologi V, Yogyakarta 1989,* Jakarta, 1989, Vol. I, pp. 200–20; 'Southeast Asian shipping in the Indian Ocean during the 1st millennium AD', in H.P. Ray and J.-F. Salles (eds), *Tradition and archaeology*, 1996, pp. 181–98; 'Les techniques de construction navale aux Maldives originaires d'Asie du Sud-Est', *Techniques & Culture,* 35–36, 2000, pp. 21–47. A large 40–50 m long tenth-century lashed-lug plank-built vessel was excavated recently in the Java Sea (no publication is available yet).
56. J.L.A. Brandes, 1889, 'De koperen platen van Sembiran (Boeleleng, Bali), oorkonden in het Oud-Javaansch en het Oud-Balineesch', *Tijdschrift voor Indische taal-, land- en volkenkunde uitgegeven door het Bataviaasch Genootschap van Kunsten en Wetenschappen,* 33 (1), pp. 16–56. Most of what is written here on the Southeast Asian *jong* is summarized from P.-Y. Manguin, 1980, 'The Southeast Asian Ship. An Historical Approach', *Journal of Southeast Asian Studies*, 11 (2), pp. 266–76, in which references to original sources are given in detail. The latter paper was written before archaeological finds started coming to light. Corrections and additions to it will be found in Manguin, 1989, 'The trading ships of Insular Southeast Asia : New evidence from Indonesian archaeological sites'; 'Trading ships of the South China Sea : Shipbuilding Techniques and their Role in the Development of Asian Trade Networks', *Journal of the Economic and Social History*

of the Orient, 36, 1993, pp. 253–80; 'The vanishing *jong* : Insular Southeast Asian fleets in war and trade (15th–17th centuries)', in A. Reid (ed.), *Southeast Asia in the Early Modern Era: Trade, Power, and Belief,* Ithaca, London, 1993, pp. 197–213.

57. N. Burningham, 2000, 'Indonesian quarter-rudder mountings', *International Journal of Nautical Archaeology,* 29 (1), pp. 100–19.
58. The two technically best descriptions of the sixteenth-century *jong* will be found in Correa, *Lendas da Índia,* I/1, pp. 216–18, and in the ca. 1582 text published in J. Wicki, 1971, 'Lista de moedas, pesos e embarcações do Oriente, composta por Nicolau Pereira S.J. por 1582', *Studia,* 33, pp. 147–48. Recent Bugis sailing ships are described in G.A. Horridge, 1979, *The Konjo Boatbuilders and the Bugis Prahus of South Sulawesi,* Greenwich; and N. Burningham, 1988, 'Description of Hati Marege, a replica 19th century Makassan perahu', *Beagle (Records of the Northern Territory Museum of Arts and Sciences),* 5 (1), pp. 155–61, to name only two relatively recent works.
59. Mentions of Southeast Asian shipping in the Indian Ocean will be found in G. Bouchon, 1979, 'Les premiers voyages portugais à Pasai et à Pégou (1512–1520)', *Archipel,* 18, p. 134 (observed at Oman); Castanheda, *História do descobrimento ...,* II/xxi, xxxix, pp. 256, 296 (Maldives and Red Sea); Duarte Barbosa, in Dames (ed.), *The Book ...,* Vol. I, p. 56, Vol. II, p. 117 (Coromandel, Sri Lanka, Aden); Tomé Pires, in Cortesão (ed.), *The Suma oriental ...,* Vol. II, pp. 174, 182, 272 (Coromandel, Bengal, Aden). On the Coromandel to Melaka trade, the most thorough study remains that of Sanjay Subrahmanyam (*A presence portuguesa ...*).
60. P.-Y. Manguin 'The vanishing jong ...', pp. 197–213; and various works by L.F.F.R. Thomaz (*Nina Chatu e o Comércio Português em Malaca,* Lisboa, 1976; 'Malaka et ses communautés marchandes au tournant du 16e siècle', *in* D. Lombard and J. Aubin (eds), *Marchands et hommes d'affaires asiatiques dans l'Océan Indien et la Mer de Chine, 13e–20e siècles,* Paris, 1988, pp. 31–48; 'The Malay Sultanate of Melaka', in A. Reid (ed.), *Southeast Asia in the Early Modern Era* , pp. 69–90. See also Tomé Pires' text in Cortesão (ed.), *The Suma oriental ...,* Vol. II, pp. 367, 496 sq.
61. The evidence from these archaeological finds was first discussed in J. Green and R. Harper, 1983, *The Excavation of the Pattaya Wrecksite and the Survey of three other Sites, Thailand 1982,* Fremantle, pp. 41–44; and in Manguin, 1984, 'Relationship and Cross-influences between Southeast Asian and Chinese Shipbuilding Traditions', in *Final Report. SPAFA Consultative Workshop on Maritime Shipping and Trade Networks in Southeast Asia,* Bangkok, pp. 197–212, 'The trading ships of Insular Southeast Asia ...', and 'Trading ships of the South China Sea ...'.
62. P.-Y. Manguin, 'Relationship and Cross-influences ...'.
63. P.-Y. Manguin, 2010, "New Ships for New Networks: Trends in Shipbuilding in the South China Sea in the 15th and 16th Centuries", in G. Wade (ed.), *Southeast Asia in the Fifteenth Century: The China Factor.* Singapore: NUS Press, p. 333–358. A thorough reappraisal of the conclusive evidence for this 'South China tradition', based on up-to-date archaeological data, was recently published by Michael Flecker, 2007, 'The South-China-Sea Tradition: the Hybrid Hulls of Southeast Asia', *International Journal of Nautical Archaeology,* 36 (1), pp. 75–90.
64. The descriptions of Ibn Battuta and Marco Polo will be found in Yule and Cordier (*Cathay and the way Thiter ...,* Vol. IV, pp. 25–26) and in Moule and Pelliot (*Marco Polo,* Vol. I, pp. 354–56).
65. Ma Huan in Mills (ed.), *Ying Yai Sheng Lan,* pp. 146–47; the *Xiyang chaogong dianlu* is quoted in R. Ptak, 1987, 'The Maldive and Laccadive Islands in Ming Records', *Journal of American Oriental Studies,* 107 (4), p. 686 (translation revised by the present author).
66. Correa, *Lendas da Índia,* II, pp. 131–32; Barbosa in Dames (ed.), *The Book ...,* Vol. II, pp. 103–04.
67. This section on the boats of the Maldives is largely based on my own observations there during a joint EFEO/NISTADS survey of traditional shipyards in the archipelago, carried out in 1988 with Dr Lotika Varadarajan (P.-Y. Manguin, 'Les techniques de construction navale aux Maldives ...'). A later survey by the Western Australian Maritime Museum reached the same conclusions about the Southeast Asian features of Maldivian vessels (K. Millar, 1993, 'Preliminary report on observations made into techniques and traditions of Maldivian shipbuilding', *Bulletin of the*

Australian Institute of Maritime History, 17 (1), pp. 9–16; see also G. Block, 1992, 'Island craft: Gus Block looks at traditional boatbuilding in the Maldives', *Classic Boat,* February, pp. 22–26.

68. Manguin, 'Les techniques de construction navale aux Maldives ...'; Tomalin et al., 'The Thaikkal-Kadakkarapally Boat ...'.
69. Moreland, 'The Ships of the Arabian Sea ...', pp. 63, 173; A. Lewis, 1973, 'Maritime skills in the Indian Ocean, 1368–1500', *Journal of the Economic and Social History of the Orient,* 16 (2–3), p. 247; K.N. Chaudhuri, 1985, *Trade and Civilisation in the Indian Ocean. An Economic History from the Rise of Islam to 1750,* Cambridge, p. 141 (contrary to the first two, the latter has a technically inadequate approach to ships and ship-building).
70. On the diffusion of outrigger technologies in the Indian Ocean, see J. Hornell, 1946, *Water Transport, Origins and early Evolution,* Cambridge, esp. Ch. XVIII.
71. S. Subrahmanyam, 'A Note on Narsapur Peta ...', p. 310; A. Das Gupta, 'Asian Shipping: A Note'.
72. A recent article by Himanshu Prabha Ray defends this point of view with illustrations taken from the history of Bengal ('The Archaeology of Bengal: Trading Networks, Cultural Identities', *Journal of the Economic and Social History of the Orient,* 49 (1), 2006, pp. 68–95).

BIBLIOGRAPHICAL NOTE

In the field of European studies of early modern and modern times, the development of maritime history in general and the history of ship-building techniques in particular have depended largely on the vast amount of documents of an economic nature preserved in archival collections. The preservation of a few technical manuals on ship-building procedures has also provided critical data, as has the study of iconographic representations. During past decades, impressive developments in nautical archaeology have finally brought about a dramatic progress in our understanding of the West European and Mediterranean shipping scenes of the past three millennia.

The contrast with Indian Ocean historiography in pre-European times is striking, as archival repositories are virtually non-existent for the region until modern times. After the end of the fifteenth century, data on Asian ships and ship-building do appear in limited quantities, gathered from the chronicles and the archives of European powers involved in the "discovery" and then the trade of Asia. The maritime and economic history of the Indian Ocean in modern times has vastly benefited from the exploitation of the archives of East India companies after the end of the sixteenth century, as other chapters in this volume will make clear.

This is not the place to debate once more on use historians can make of indigenous written sources produced in the Middle East, in South or Southeast Asia. Limiting ourselves to the field of ship-building traditions, suffice it to say that sources from which exploitable technical data on ships and shipping may be extracted are more than scarce. Most, if not all, information gathered from such written sources is at best circumstantial or anecdotal. Iconographic sources are similarly scarce and more often than not of little relevance for practical purposes, as scale factors (as in coins) or the unfamiliarity of artists with sailing ships and their gear have left us with data which are, at best, problematic. After R.K. Mookerji's pioneering work (*Indian Shipping. A History of the Sea-Borne Trade and Maritime Activities of the Indians from the Earliest,* Bombay, 1912, 2nd revised edn Bombay, 1957), many authors followed, each bringing forward some formerly unpublished textual or iconographic data; however, recent publications contain very little new material, and turn out to be, more often than not, a rehash (often a narrow regional perspective) of an earlier work.

A short list of essential reading centred on South Asia would include: W.H. Moreland, 1939, "The Ships of the Arabian Sea about 1500 A.D.", *Journal of the Royal Asiatic Society,* pp. 63–74, 173–92; A.L. Basham, 1964, "Notes on Seafaring in Ancient India", *Studies in Indian History and Culture,* Calcutta, pp. 146–66; L. Gopal, 1962, "Art of Shipbuilding and Navigation in Ancient India", *Journal of Indian History,* 40 (2), pp. 313–27, and "Indian Shipping in early Mediaeval Period", in *India's Contribution to World Thought and Culture,* Madras, 1970, pp. 108–22; A. Jan Qaisar, 1968, "Shipbuilding in the Mughal Empire during the Seventeenth Century", *Indian Economic and Social History Review,* 5 (2), pp. 149–70, and *The Indian Response to European Technology and Culture (A.D. 1498–1707),* Delhi, 1968; A. Lewis, 1973, "Maritime skills in the Indian Ocean, 1368–1500", *Journal of the Economic and Social History of the Orient,* 16 (2–3), pp. 238–64; D. Schlingloff, 1968, "Indische Seefahrt in Romischer Zeit", in H. Muller-Karpe (ed.), *Zur Geschichtlichen Bedeutung der fruhen Seefahrt,* Munchen, pp. 51–85, and relevant passages of his *Studies in the Ajanta Paintings: Identifications and Interpretations,* New Delhi, 1987; M. Chaudhuri, 1976, "Shipbuilding in the *Yuktikalpataru* and the *Samarangana sutradhara*", *Indian Journal of Historical Science,* 11, pp. 137–41; S. Digby, 1982, "The Maritime Trade of India, c.1200–1500", in T. Raychaudhuri and Irfan Habib (eds), *The Cambridge Economic History of India,* Cambridge, Vol. I, pp. 125–59; J. Deloche, 1978, "Techniques anciennes de constructions navales en Inde: le problème de la liaison des bordages (sources et méthodes)', in *VIth European Conference on Modern South Asian Studies,* Paris, *La circulation en Inde avant la révolution des transports.* Tome II: *La voie d'eau,* Paris, 1980, "Le bateau de Tirupputaimarutur (Sud de l'Inde)", *Bulletin de l'Ecole française d'Extrême-Orient,* 72, 1983, pp. 1–12, and "Konkan Warships of the XIth–XVth Centuries as Represented on Memorial Stones", *Bulletin de l'Ecole française d'Extrême-Orient,* 76, 1987, pp. 165–84; B. Arunachalam, 1990, "Indigenous Traditions of Indian Navigation with Special Reference to South India", in K.S. Mathew (ed.), *Studies in Maritime History,* Pondicherry, pp. 127–42; S. Devendra, 2002, "Pre-Modern Sri Lankan Ships", in D. Parkin and R. Barnes (eds), *Ships and the Development of Maritime Technology in the Indian Ocean,* London, pp. 128–73; H.P. Ray, 2003, *The Archaeology of Seafaring in Ancient South Asia,* Cambridge. Many other books have been recently published in India which deal with this increasingly popular genre of maritime history; with changing perspectives, depending on the state in which they have been published, and some original regional linguistic and ethnographic evidence, they tend to simply repeat the data published earlier when it comes to describing ancient ships, and pay little or no attention to diagnostic structural details (see, among recent examples, L.N. Swamy, 1997, *Boats and Ships in Indian Art,* New Delhi, and *Maritime Contacts of Ancient India: With Special Reference to West Coast,* New Delhi, 2000; S. Tripati, 2000, *Maritime Archaeology: Historical Descriptions of the Seafarings of the Kalingas,* New Delhi).

Perspectives from the western coasts of the Indian Ocean are provided in the pioneering work of G.F. Hourani, 1951, *Arab Seafaring in the Indian Ocean in Ancient and Early Mediaeval Times,* Princeton (reprinted with additions by J. Carswell in 1995); A. Lewis, 1973, "Maritime skills in the Indian Ocean, 1368–1500", *Journal of the Economic and Social History of the Orient,* 16 (2–3), pp. 238–64; D.A. Agius, 1999, "Medieval Qalhat: Travellers, Dhows and Stone Anchors in South-East Oman", in Himanshu Prabha Ray (ed.), *Archaeology of Seafaring: The Indian Ocean in the Ancient Period,* New Delhi, pp. 173–220, and "Classifying Vessel-Types in Ibn Battutta's *Rihla*", in D. Parkin and R. Barnes (eds), *Ships and the Development of Maritime Technology in the Indian Ocean,* London, 2002, pp. 174–208.

Compared with Europe and the Mediterranean, however, the sailing world of the Indian Ocean and its adjoining seas has an immense advantage: until recently, the ship-building and sailing scenes along its coasts provided observers with a vast repository of traditional practices, bridging a wide variety of technical developments. Some, as noted in the preceding chapter and its endnotes, were recorded in medieval times by those few European, Arabic and Chinese travellers who were curious enough to observe them and dedicated enough to put their observations into writing. True marine ethnography started in the late eighteenth and early nineteenth centuries, when Enlightenment and new perceptions of the world triggered encyclopaedic approaches to recording mankind's ingenuity in the nautical scene. For the overall Asian scene, the best example remains Admiral Edmond Pâris' meticulous *Essai sur la construction navale des peuples extra-européens,* Paris, 1841, but many other works were put to good use, in combination with written and iconographic sources, to write the first generation of pioneering histories of Indian Ocean navies. Regional as well as all-encompassing studies on seafaring were pioneered by James Hornell after the 1920s ("The Origins and Ethnological

Significance of Indian Boat Designs", in *Memoirs of the Asiatic Society of Bengal,* 7 [3], 1920, pp. 139–257; "The Tongue and Groove Seam of Gujarati Boatbuilders", *Mariner's Mirror,* 16 [4], 1930, pp. 309–12; "The Sailing Craft of Western India", *Mariner's Mirror,* 32, 1946, pp. 195–217; his most important works were republished in his *Water Transport, Origins and early Evolution,* Cambridge, 1946). More recently, Basil Greenhill devoted much of his own ethnographical work to Pakistan craft ("The Boats of East Pakistan a Preliminary Study", *Mariner's Mirror,* 43 [2, 3], 1957, pp. 106–34, 203–15; *Boats and boatmen of Pakistan,* Newton Abbot, 1971), and placed Indian Ocean craft in a broader perspective in his much respected *Archaeology of the Boat,* London, 1976.

In the face of the accelerating pace of globalization and the quickly disappearing regional traditions of ship-building, ethnographic observations of seafaring in the Indian Ocean have taken a new turn in past years. The successors of B. Greenhill at the Greenwich Maritime Museum have followed in his steps: S. McGrail (ed.), 2003, *Boats of South Asia,* London; S. McGrail and E. Kentley (eds), 1985, *Sewn Plank Boats: Archaeological and Ethnographic Papers Based on Those Presented to a Conference at Greenwich in November, 1984,* Oxford, National Maritime Museum, Greenwich (BAR International Series 276); E. Kentley, 1985, "Some Aspect of the Masula Surf Boat", in S. McGrail and E. Kentley (eds), *Sewn Plank Boats ...,* pp. 303–17; E. Kentley and R. Gunaratne, 1987, "The madel paruma: a sewn boat with chine strakes", *International Journal of Nautical Archaeology,* 16 (1), pp. 35–48. Sean McGrail also produced an updated major comparative synthesis on seafaring that includes the most recent developments in Asian ethnographical and archaeological data gathering: *Boats of the World: from the Stone Age to Medieval Times,* Oxford, 2001. Indian programmes have also resulted in precious work: Lotika Varadarajan, 1993, "Indian boat building traditions. The ethnological evidence", *Topoi,* 3 (2), pp. 547–68, and *Sewn Boats of Lakshdweep,* Goa, 1998; H.P. Ray, 1996, "Maritime archaeology: The ethnographic evidence", *Man and Environment,* 21 (1), pp. 74–85, and "Shipping in the Indian Ocean: An Overview", in D. Parkin and R. Barnes (eds), *Ships and the Development of Maritime Technology in the Indian Ocean,* London, 2002, pp. 1–27.

The Arabo-Indian dhow scene is best illustrated in G.R. Tibbetts, 1972, *Arab Navigation in the Indian Ocean before the Coming of the Portuguese,* London; C.W. Hawkins, 1977, *The Dhow. An Illustrated History of the Dhow and its World,* Lymington; B. Martin, 1982, "The Present-day Dhow Trade of India", *Great Circle,* 4 (2), pp. 105–18; T.A. Vosmer, 1993, 'A survey of traditional vessels of the Sultanate of Oman: The Omani dhow recording project', Field Research 1992, Fremantle, Department of Maritime Archaeology, Western Australian Maritime Museum (Report no. 69), and in a variety of papers published in S. McGrail and E. Kentley (eds), *Sewn Plank Boats.*

Southeast Asia, with the ubiquitous presence of Austronesian seafarers all along its coasts and islands, had kept a dynamic tradition of building large sailing traders (the Bugis *pinisi* being the best known of such vessels) alive until the second half of the twentieth century. Ethnographic studies have been exceedingly abundant; only a few important works on Malay World craft dealing with those craft involved in past Indian Ocean shipping and probable interaction with other Indian Ocean technical traditions can be cited here: G. Ammarell, 1999, *Bugis Navigation.* New Haven, Yale Southeast Asia Studies, Monograph 48; R.H. Barnes, 1985, "Whaling Vessels of Indonesia", in S. McGrail and E. Kentley (eds), *Sewn Plank Boats,* pp. 345–66, and "Yami Boats and Boat Building in a Wider Perspective", in D. Parkin and R. Barnes (eds), *Ships and the Development of Maritime Technology in the Indian Ocean,* London, 2002, pp. 291–314; N. Burningham, 1987, "Reconstruction of a Nineteenth Century Makassan 'perahu'", *Beagle (Records of the Northern Territory Museum of Arts and Sciences),* 4 (1), pp. 103–28, and "The Structure of Javanese Perahus", *Beagle (Records of the Northern Territory Museum of Arts and Sciences),* 6 (1), 1989, pp. 195–219; G.E.P. Collins, 1937, *Makassar Sailing,* London; C.A. Gibson-Hill, 1949, "Cargo Boats of the East Coast of Malaya", *Journal of the Malayan Branch, Royal Asiatic Society,* 22 (3), pp. 106–25, and "The Indonesian Trading Boats Reaching Singapore", *Journal of the Malayan Branch, Royal Asiatic Society,* 23 (1), 1950, pp. 108–38; C.W. Hawkins, 1982, *Praus of Indonesia,* London; G.A. Horridge, 1979, *The Konjo Boatbuilders and the Bugis Prahus of South Sulawesi,* London, National Maritime Museum (Maritime Monographs and Reports, 40), *The Lashed-lug boats of the Eastern Archipelagoes, the Alcina MS and the Lomblen Whaling boats,* Greenwich, 1982, and *The Prahu: Traditional Sailing Boat of Indonesia,* Singapore, 1985; Sudjoko, 1981, *Ancient Indonesian Technology: Ship Building and Fire Arms Production Around the Sixteenth Century,* Jakarta, Aspek-aspek Arkeologi Indonesia, 9.

A flurry of books centred on the archaeology of trade and seafaring in South Asia and the Indian Ocean have been published in the past few years, bringing together individual or edited works with a variety of methodologies and taking into consideration new data and new approaches: S.R. Rao (ed.), 1988, *Marine archaeology of the Indian Ocean Countries. Proceedings of the First Indian Conference on Marine Archaeology of Indian Ocean Countries, Jamnagar, 1987,* Goa; J. Reade (ed.), 1996, *The Indian Ocean in Antiquity,* London; K.S. Mathew (ed.), 1997, *Ship-building and Navigation in the Indian Ocean region AD 1400–1800,* New Delhi; H.P. Ray (ed.), 1999, *Archaeology of Seafaring: The Indian Ocean in the Ancient Period,* New Delhi; H.P. Ray and J.-F. Salles (eds), 1996, *Tradition and archaeology. Early maritime contacts in the Indian Ocean,* Lyon, New Delhi; H.P. Ray, 2003, *The Archaeology of Seafaring in Ancient South Asia,* Cambridge; D. Parkin and R. Barnes (eds), 2002, *Ships and the Development of Maritime Technology in the Indian Ocean.* London.

However, despite the creation of a marine archaeology department at the Goa Institute of Archaeology in the 1980s, not a single underwater shipwreck site with remains of Asian vessels has yet been investigated in South Asia and the Middle East (a department of underwater archaeology was only very recently created at the Archaeological Survey of India). So far, the only ancient Arabo-Indian vessel has been excavated and published by M. Flecker in the Java Sea: "A 9th-century Arab or Indian shipwreck in Indonesian waters", *International Journal of Nautical Archaeology,* 29 (2), 2000, pp. 199–217, and "A Ninth-century Arab or Indian shipwreck in Indonesian waters", *World Archaeology,* 32 (3), 2001, pp. 335–54. The other large vessel only recently brought to light is an inland craft from Kerala: R.K. Pedersen, 2004, "The Shipwreck at Coconut Grove: The Kadakkarapally Boat", *Institute of Nautical Archaeology Quarterly,* 31 (2), pp. 3–9; V. Tomalin, V. Selvakumar, M.V. Nair, P.K. Gopi, 2004, 'The Thaikkal- Kadakkarapally Boat: An Archaeological Example of Medieval Shipbuilding in the Western Indian Ocean', *International Journal of Historical Archaeology,* 33 (2), pp. 253–63.

Southeast Asian countries (especially Thailand) and China, in contrast, have been heavily involved for long in nautical archaeology and the acquisition of data from ancient shipwrecks. An extensive article by Jeremy Green, a pioneer underwater archaeologist in Asian waters, summarizing the situation in 2001, does not come out with a single Asian underwater archaeological site west of the South China Sea and Southeast Asia, whereas some 40 sites with identified timber remains are known today, dating from the last two millennia (many more are known for their cargo only, mainly ceramics): "The archaeological contribute to the knowledge of the extra-European shipbuilding at the time of Medieval and Modern Iberian-Atlantic tradition", in F. Alves (ed.), *Proceedings, International Symposium on Archaeology of Medieval and Modern ships of Iberian-Atlantic tradition, Work Sessions,* Lisboa, 2001, pp. 63–103. Detailed references to specific archaeological sites or technical features revealed in shipwreck sites of Southeast Asia have been given in the endnotes of this chapter. Contrary to the Indian Ocean proper, there are no recent comprehensive studies devoted to ship-building and seafaring in Southeast Asian waters. Only those articles devoted to the history and archaeology of ship-building, providing general, comparative information on these matters, are listed below: M. Flecker, 2002, *The Archaeological Excavation of the 10th Century Intan Shipwreck, Java Sea, Indonesia,* Oxford, British Archaeological Reports, International Series 1047, and "The South-China-Sea Tradition: The Hybrid Hulls of Southeast Asia", *International Journal of Nautical Archaeology,* 36 (1), 2007, pp. 75–90; P. Clark, J. Green, R. Santiago, T. Vosmer, 1993, "The Butuan Two boat known as balangay in the National Museum, Manila, Philippines", *International Journal of Nautical Archaeology,* 22 (2), pp. 143–59; J. Green and R. Harper, 1983, *The Excavation of the Pattaya Wrecksite and the Survey of three other Sites, Thailand 1982,* Fremantle, Australian Institute of Maritime Archaeology; P.-Y. Manguin, 1980, ''The Southeast Asian Ship. An Historical Approach", *Journal of Southeast Asian Studies,* 11 (2), pp. 266–76, "The Trading Ships of Insular Southeast Asia : New Evidence from Indonesian Archaeological Sites", *Proceedings, Pertemuan Ilmiah Arkeologi V, Yogyakarta 1989,* Jakarta, Vol. 1, 1989, pp. 200–20, "Trading ships of the South China Sea : Shipbuilding Techniques and their Role in the Development of Asian Trade Networks", *Journal of the Economic and Social History of the Orient*, 36, 1993, pp. 253–80, "The Vanishing Jong : Insular Southeast Asian Fleets in War and Trade (15th–17th Centuries)", in A. Reid (ed.), *Southeast Asia in the Early Modern Era ...*, pp. 197–213, "Southeast Asian shipping in the Indian Ocean during the 1st millennium AD", in H. P. Ray and J.-F. Salles (eds), *Tradition and archaeology...*, 1996, pp. 181–98, "New ships for new networks: trends in shipbuilding in the South China Sea in the 15th and 16th centuries", in G. Wade (ed.), *Southeast Asia in the Fifteenth Century: The China Factor.* Singapore: NUS Press, 2010, p. 333–358.

On early modern Chinese shipping in the Indian Ocean, recent readings include C. Wake, 1997, "The Great Ocean-going Ships of Southern China in the Age of Chinese Maritime Voyages to India, Twelfth to Fifteenth Centuries", *International Journal of Maritime History,* 9 (2), pp. 51–82, and D.A. Agius, 2002, "Classifying Vessel-Types in Ibn Battutta's *Rihla*", in D. Parkin and R. Barnes (eds), *Ships ...*, 2002, pp. 186–88. It should be noted here that most of the preposterous and over-publicized claims of Gavin Menzies about world-wide Chinese maritime ventures in his *1421* bestseller are nothing but fiction (G. Menzies, 2003, *1421: The Year China Discovered the World,* London). On recent reassessments of the Zheng He episode of Chinese maritime history, see G. Wade, 2005, 'The Zheng He Voyages: A Reassessment', *Journal of the Malayan Branch, Royal Asiatic Society,* 78 (1), pp. 37–58, and the various chapters in C. Salmon and R. Ptak (eds), 2005, *Zheng He: Images & Perceptions, Bilder & Wahrnehmungen,* Harrassowitz Verlag, South China and Maritime Asia 15 (particularly that by S.K. Church on the expedition ships: "The Colossal Ships of Zheng He: Image or Reality ?", pp. 155–76). By far the best studies of Chinese ship-building traditions can be found in J. Needham, 1971, *Science and Civilisation in China,* Vol. IV/3: *Civil Engineering and Nautics,* Cambridge, and in J. Dars, 1992, *La marine chinoise du Xe siecle au XIVe siècle,* Paris.

There are only a few reports in Western languages providing details on shipwrecks recovered in Chinese waters (now at an accelerating pace). As noted earlier in this chapter, these do not belong to the Indian Ocean craft traditions *stricto sensu,* but have sailed at times on Indian Ocean lanes. Trade has mainly been with Southeast Asia and technical interaction with the region's shipbuilding traditions. A few references on Chinese shipwreck archaeology should nevertheless be quoted here, as they provide broad comparative data: J. Green, 1983, "The Song Dynasty Shipwreck at Quanzhou, Fujian Province, People's Republic of China", *International Journal of Nautical Archaeology,* 12 (3), pp. 253–61; M. Flecker, 2007, "The South-China-Sea Tradition: The Hybrid Hulls of Southeast Asia", *International Journal of Nautical Archaeology,* 36 (1), pp. 75–90; P.-Y. Manguin, 2010, "New ships for new networks: Trends in shipbuilding in the South China Sea in the 15th and 16th centuries", in G. Wade (ed.), *Southeast Asia in the Fifteenth Century: The Ming Factor,* Singapore.